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BRITISH MANUFACTURES AND THE POLICY OF UNFETTERED COMMERCE.

By Edward Atkinson, LL. D., Ph. D.

With British manufacturers beginning to talk of governmental protection against foreign competition, and with American manufacturers, in rapidly increasing numbers, already agitating for a reduction of tariff duties, especially upon raw materials, it seems high time for thoughtful consideration of the subject. For at bottom the tariff question everywhere is a matter of plain business, and must ultimately be settled through the active influence of business men acting for business reasons and entirely apart from politics. We are especially pleased, therefore, in being able to present two timely and notable discussions of the subject—the first by Mr. Edward Atkinson, who stands in the front rank of American economists and who writes from New England, the home of the American protective system; and the second by Mr. William L. Saunders, who is prominent in the American National Association of Manufacturers, and who, as vice-president and general manager of a great engineering firm doing business with all the world from London and Melbourne, as well as New York, writes as a business man without regard to political or partisan considerations.—THE EDITORS.

IN a recent address by Lord Rosebery at the annual meeting of the Wolverhampton Chamber of Commerce he used one expression which is very surprising, coming as it does from one who is the potential leader of the liberal party of the United Kingdom. He said "the war he feared (in the future) was not a military war, but the war of trade which was inevitable. * * * There were two nations which were obviously our rivals and opponents in this commercial war, America and Germany." The use of the word "war" in this connection is much to be regretted. It is probable that Lord Rosebery used it unthinkingly. It is wholly inconsistent with the fundamental principle and conception

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of the policy of free trade. The idea which it represents is but a survival of the mediaeval theory that in international commerce or trade what one State or nation gains another must lose. This false conception of commerce has retarded the progress of the world and has been the cause of more criminal aggression of one country upon another than any other fallacy that ever misled the human mind. This same delusion brought about the separation of the Colonies of America from the mother country, which Lord Rosebery so deplores. If the use of the word "war" were fit or proper in dealing with international trade, it would bar the way to the future re-union of the English-speaking people, not in government, but in reciprocal commerce, in pursuance of their mutual interests and interdependence, which Lord Rosebery so earnestly seeks. There have been, there are now, and there may for a short time continue to be, wars of tariffs; but a war of trade is unthinkable to any one who has a true conception of the benefits of commerce and of the principles which governed Peel, Gladstone, Bright and Cobden in the adjustment of the British revenue systems in such a manner as to open wide the doors of Great Britain to all the commerce of the world. And yet the term "British free trade" is not fully warranted. Englishmen have no title to arrogate it solely to themselves. The Netherlands anticipated Great Britain by two centuries or more, conducting their long struggle with Spain on a free-trade basis, emerging from it rich and prosperous, the rival of England on the sea and the peer of any nation in commerce, while Spain entered upon her period of decadence for the very reason that her rulers were actuated by the same fallacies that Lord Rosebery unthinkingly admits when he uses the phrase "a war of trade."

Another fact has almost escaped attention. The prosperity of the United States, the diversity of their industries, the growth of their mining, metallurgy and manufactures, and the vast development of their agriculture, are due to the American system of almost continental free trade, such as never existed over so great an area before and such as has never been enjoyed by so large a number of people. In fact, free trade among the States is the bond that keeps the nation in existence. The war of tariffs between the Confederated States after the treaty of peace in 1783, and before the adoption of the constitution in 1789, led to actual warfare on a small scale between New York and Connecticut. These wars of tariffs between the States nearly caused the disruption of the union. American free trade on a continental scale had fully justified itself half a century before the British protective system culminated in disaster in 1840.

To what desperate straits the British nation had been brought by the policy of protection is witnessed by the words of Sir Robert Peel when he described the conditions in which he found her trade, commerce, and manufactures in 1840. He attributes these adverse conditions to the efforts that had been made to develop and protect the home market and to prevent other nations from supplying the wants of the people. This was the result of legislation governed by the fallacy of a "war of trade." I may quote from memory some extracts from Peel's speeches. In one he said, substantially in these words, "What conditions do we now witness? Our ships rotting at the wharves; our manufacturing population rioting in the streets; our agricultural population starving in the fields; the Chancellor of the Exchequer seated on an empty chest, over the pool of a bottomless deficiency, fishing for a budget. * * * The policy which we have adopted and continued for the purpose of developing and retaining the home market has almost destroyed that market by reducing the great mass of the population to beggary, destitution, and want."

The American system of free trade on a continental scale, coupled with slight dependence on foreign countries for any of the necessaries of life and for few of the materials used in manufactures, has prevented any such generally adverse conditions in the United States; but there are arts, notably the wool and woolen trade at the present time, in which the adverse conditions due to a bad tariff closely correspond to those pictured in Peel's speeches.

I may venture upon a little personal reminiscence at this point. On one of my visits to London when Mr. Gladstone was Prime Minister and at the height of his power I was a guest of the Economy Club at a meeting where the late Professor Sidgwick was announced to read a paper on "Some exceptions to the Application of the Principle of Free Trade." We had taken our seats, myself at the right of the chairman, Mr. G. J. Shaw Lefevre, as the guest of the evening, when Mr. Gladstone appeared, for the first time in seven years at a meeting of the club, doubtless attracted by the title of the paper. Professor Sidgwick took the ground closely corresponding to that of John Stuart Mill, and also to Alexander Hamilton's theory of protection from which we have so widely departed, namely: that certain industries which are deemed of national importance, like iron and textiles, may be rightly aided by government in their early period. Mr. Gladstone responded indirectly by giving a half-hour of most interesting reminiscences of the great contest from the time of Huskisson in

1824 to the close of the matter under himself in 1856. To my dismay I was next asked as "the stranger" to give my views. I was called upon to think quickly, and I decided to astound my hearers by direct denial of Professor Sidgwick's thesis, basing my denial wholly upon the experience of the United States. The words which I then spoke would be fitting words in this discussion.

"Mr. Sidgwick holds that the success of certain important branches of manufacture which are in their infancy may rightly depend on temporary protection granted by the government. I shall disprove this theory by stating facts derived from the experience of the United States of America." I paused a moment to observe the shock of surprise that went around the table, and then said, "You will bear in mind that for nearly a century, since the adoption of our constitution, the benefit of absolute free trade has been enjoyed in the United States over a wider area and among a greater number of people than ever before were permitted the privilege of free commerce in the history of the world. This area is endowed with greater internal resources and possesses a more varied climate, from almost tropical to almost frigid, than any other great single State with the possible exception of Russia. The systems of law vary from the Roman law established in Louisiana to the common law of England in Massachusetts. The methods of local taxation are very different. These variations among the States, coupled with as great variation in race, color, and condition of the inhabitants, exceed the differences which prevail among the several states of Europe; yet compulsory free trade has been the bond of union among them and has made their interdependence the vital fact in their history, notwithstanding the fact that over almost half our settled territory the theory of protection or privation of liberty was carried to its logical end in the internal affairs of the States themselves. Until 1865 the employer of labor not only directed the laborer, but he owned him. Under that condition these States were subjected to the evil which the advocate of protection holds out as the necessary result of free commerce. The southern slave-stricken community was devoted almost exclusively to agriculture. There was little or no development of manufactures except in home-spun fabrics. There were few or no mechanics except the slave blacksmiths and carpenters bred on the great plantations. That system culminated in the civil war by which slavery destroyed itself. The southern States were then left without capital. The wealth which had been inherited had nearly all been taken away by the emancipation of the slaves. The railroad system was destroyed. There was no inherited aptitude among the whites for the manufacturing arts, for mechanic arts, or for mining. But these States were subject to the absolutely free competition of the great iron works of Pennsylvania, the huge textile factories of New England, and the wood-working shops of the great west and north.

Little more than half a generation has elapsed since the infant industries of the new south were undertaken. What are the present conditions? (This was, I think, in the year 1893.) Pennsylvania striving by the adoption of every possible improved method to meet the competition of the iron furnaces of Alabama. New England trembling lest the center of the textile arts shall be moved from Massachusetts and Rhode Island to the Carolinas and Georgia. The woodworking shops of the middle south competing with the great establishments in the middle west. I think I need make no further rejoinder to Professor Sidgwick's plea for even temporary protection to infant industries. Let these facts speak for themselves." There was little further discussion at that meeting.

I cite this incident because of its application to the present conditions of the United States and the United Kingdom. Can there be a "war of trade" between the two great branches of the English-speaking people in their effort to supply each other's wants in the peaceful commerce which is annually increasing in volume and importance? Can there be a "war of trade" between the United States and Germany or France, even though there is now a war of tariffs between them? It will be observed that the United States, the United Kingdom of Great Britain and Ireland, Germany, France, and Belgium are the only States to which the rest of the world can look for the principal supply of the wants of the people with the products of the mill, the mine, the furnace, and the workshop. Their population numbers in round figures 220,000,000. The computed population of the world numbers 1,500,000,000. Is there not room for the work of all the manufacturing States in supplying the increasing wants of the non-manufacturing continents, islands, and countries which are now being so rapidly developed by the railway and the steamship? Was there any "war of trade between the northern and southern iron and textile masters of the United States? Far from it. They rivaled each other in the exchange of services, each section supplying the other not only with machinery, but with the ideas and rules governing production and the men capable of putting them into practice. Presently they began to exchange products. The crude iron was sent from Alabama to Pittsburgh to be converted into machinery. The gray cloth was sent from the southern mills to Massachusetts and Rhode Island to be bleached and printed. In this mutual service and in the stimulus to improvement is to be found the key to the rapid extension of American exports to other countries. How would it have been had obstructions been put in the way of service between the States, and had the effort been made to promote the arts in each of these sections by the bounties and subsidies of the protective system, each section cut off by a war of tariffs in place of each striving to gain skill and thereby to reduce the cost of labor? This development has been accomplished not by oppression of the laborer, but by advancing the rates of wages under the necessary competition which governs wages, the efforts of capitalists to secure the highest skill. Under this influence rates of wages have been carried to the highest point ever attained in the United States or any other country, while the cost of labor in each unit of product has been reduced to the lowest point.

What stands in the way of similar benefits being exchanged between the five great manufacturing States or nations of the world that I have previously named, except the existing war of tariffs, which has been generated in the false idea that there can be a "war of trade," to which Lord Rosebery has given such unthinking expression? It may not be denied that under a zollverein or substantially free system of trade, new adjustments of the different branches of industry of the manufacturing States and nations of the world would be made. In fact, under existing conditions they must be made. This readjustment cannot be brought about without a good deal of difficulty and some special personal disaster, especially in Great Britain. The far-sighted thinking men of Great Britain have long foreseen the supremacy of the United States in the production of coal and iron. They have long been aware of the consequent transfer of the dominion of steel to that country, and they have been warned that the paramount control of the great commerce of the world would pass to the United States with this paramount production of steel whenever the United States ended the war of tariffs and removed the obstructions of their own system, especially by taking off the taxes from the crude products of Asia, Australia, Africa, and South America. America once nearly gained the leading position with her fleet of wooden ships, built at high wages and low cost by the application of science and skill to that art. She will resume that position in the construction of a fleet of steel whenever she removes the obstruction of her navigation laws, which have driven her flag from the commerce of the ocean.

Before dealing with this paramount factor in commerce, the control of steel, one may be permitted to remark that although two of the wisest addresses have been made by the Right Honorable George J. Goschen on "The Imagination a Potent Factor in Commerce," Britons are, as a rule, somewhat deficient in that faculty. The supremacy of Great Britain in commerce and manufactures, since the adoption of the free-trade policy and the repeal of the navigation acts, has been so complete and absolute as to have prevented Englishmen, with few exceptions, even imagining that with the progress of science and invention in their special application to coal, iron, and steel their paramount position could ever be endangered. Although Jevons had warned them thirty years ago of the danger of an increasing cost of coal;* although Gladstone long since foresaw the adoption by the United States either of free-trade or a low tariff policy, and the extension of American commerce which would surely ensue in urgent competition with British goods; although Cobden, Bright, and Gladstone worked earnestly to keep the peace and to pay the national debt in preparation for American competition; although Lowthian Bell pronounced the deposits of iron ore in close proximity to coal in Alabama to be the "imperial deposits" of the world, when scarcely a mine had been opened—it had not entered the imagination of the average Englishman, and especially of the British workman, until very recently, that the supremacy of the United Kingdom in manufactures and commerce could ever be imperilled. Even though Cobden and Bright knew better, their supporters of the so-called Manchester School never imagined existing conditions! They believed the United States to be a great farm and forest from which Great Britain might secure food, fibres, and timber. They thought the two nations were complements of each other and that they might exchange products to the benefit of both, the one supplying the other with the products of agriculture the other returning manufactured goods. It did not occur to them that the conditions and character of the people of the United States rendered it certain that manufacturing and mechanic arts would surely develop in due proportion to the extension of agriculture. This rule has been made plain in the development of the country. Where there is but little good land and where the climate renders indoor work desirable, as in

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* The next discovery of science may be the success of one of the many undertakings to convert coal into electric energy without the enormous waste of the present practice in steam engines and boilers. When that discovery is made it portends another industrial revolution. It would not, however, greatly change the relative power of countries according to their supply of iron ores suitable for making steel. The next subsequent great invention may be one which will render the choice of ores for steel-making unimportant, by rendering the separation of injurious elements a matter of simple and common practice.

New England, the proportion of the population occupied in the manufacturing and mechanic arts is large,—the proportion in agriculture is small,—but in all other parts of the country the manufacturing and mechanic arts have developed in regular sequence and proportion. Wherever deposits of iron ore were found in the colonies, when iron was made with charcoal, the iron and steel industries were established within twenty years from the date of the first settlement, either by the colony or subsequently by the State. Wherever iron or coal have been found in any of the States subsequently to the smelting of iron with coal, the iron industry has established itself irrespective of tariffs or of any other condition than the immediate needs of the neighborhood.

Nearly every important art had passed or was passing through its infant stage before any tariff had been enacted by the United States. In Alexander Hamilton's notable report, when he first proposed a slight protection to infant industry, the list of manufactures already "successfully established" covers every one of the existing arts, which have since been clamorous for protection, except those due to subsequent invention. Even in respect to cotton, the manufacture was already established before the invention of the cotton gin, and Hamilton proposed a repeal of the tariff tax of three cents a pound on India cotton in order to promote an industry already successfully begun. It is due either to the lack of imagination or to over-confidence resulting from the long supremacy of the British in manufactures and commerce that, when the new conditions are suddenly brought before them, there is an expression of alarmed surprise at the rapid extension of exports from the United States. This great extension of exports did not take place until the disparity which American duties on pig iron had caused in the price of iron to home consumers, as compared to those of Great Britain, had disappeared. In 1890-91 the vast iron and coal resources of the United States had been developed. This brought about home competition among American iron furnaces with the effect of bringing the price of iron and steel to the level of British prices, and soon to a lower level. All that had prevented the construction of ocean steamships, of heavy machinery, tools, and other metallic products for export had been the disparity in the price of iron. The United States' tariff had so long protected the iron masters of the United Kingdom that it does not seem to have occurred to them that America would ultimately be enabled to make iron and steel at a less cost, even though paying very much higher wages. The coal mines of the United States being upon the surface, readily worked, and the iron mines either in actual proximity or brought into close proximity by the low rates charged on the railways, justify high wages and low cost of production. The output of iron per man lately disclosed in official figures brings this point into conspicuous notice. The real effect of the duties on iron imposed by the United States during ten years from 1880 to 1889 was to protect the metal workers of Europe in their control of all other markets, in the supply of machinery, tools, engines, and even in part meeting the demand of the United States, at the same time building up the great fortunes of American iron and steel makers. The increase in the price of crude iron to the metal users of the United States, as compared to the price charged to the consumers of British iron, was $7 per ton, on an average consumption of iron in the United States of 10,000,000 tons a year. The cost of protection to iron in the ten years was $700,000,000—a bounty more than equal to the value of all the iron furnaces, rolling mills, and steel works in the United States in 1891.

All these conditions are now changed. The United States have become independent in respect to all metals except tin; in respect to fibres with the exception of silk and flax, since it is now evident that if the duties which have brought about very adverse conditions in the wool and woolen industry were wholly removed, the demand for American wool would be vastly greater, a free supply of all the wools of the world in order to make suitable combinations being absolutely necessary to the success of the woolen and worsted manufacture taken as a whole. The United States are independent of all other countries in food, timber, fuel, ores, and nearly every necessary article that enters into the products of domestic industry. On the other hand, Great Britain, France, and Germany, the great manufacturing states of Europe, have become largely dependent upon America for food, fibres, timber, and fabrics of many kinds. Perhaps that list will soon include coal and crude iron and steel, although it is not desirable on the part of the United States that they should become great exporters of coal, even though they have such an abundance. The exports of the country mainly consist of the surplus products which are not needed and which could not be consumed, all having enough; while the exports of Great Britain, France, and Germany consist mainly of goods and wares which they must sell in order to obtain means of buying the very necessaries of life and the crude materials of foreign origin without which their manufactures could not have attained their present stage

The huge traffic between Great Britain and the United States proves how close the trade alliance for the mutual benefit must of necessity hereafter be between the two branches of the English-speaking people. The figures of the export from the United States, compared with the import figures of the continental States of Europe, show how absurd the project is of the great land-holders, called Agrarians, and other privileged classes in Germany to join in a tariff war against the cheap labor of America—not the pauper labor, but the highly-paid labor. Success in the effort to boycott the food, fibres, and fabrics of the United States by heavy taxes imposed under a tariff war would endanger all the manufacturing industry of Germany by increasing its cost, while at the same time if it had any effect in the United States it would be to reduce the cost of food and crude materials to home manufacturers, and thus enable them to take the control of all the great markets of the world outside of Europe, of which they have as yet only taken a moderate share. The lesson which Germany and France have yet to learn is the one that Great Britain learned fifty years since and that the people of the United States are now so rapidly mastering; namely, *that a tariff war on foreign imports is the greatest possible obstruction to the exports of domestic products.* For more than fifty years the relatively high wages of Great Britain, as compared to those of the continental States, and the low cost of her labor due to skill and invention, have enabled her to dominate the commerce of the world. America is bound to share in larger and larger measure in that commerce as time goes on. The people of the United States are rapidly learning that there is nothing so dear as the so-called pauper or unskilled labor of other continents; nothing so cheap as the highly-paid workmen who are competent to operate modern mechanism. That State which possesses the greatest abundance of fertile land, of timber, of ore, and of coal, may with half the labor required under other conditions, measured by hours or physical energy, secure double the product of the less capable or less well-endowed workmen of other lands. If the rate of wages or earnings of the workmen of a country governed and established the cost of labor in the product, not one dollar's worth of exports could pass out from American harbors. There is not a single article exported, cotton or corn, ore or metal, machine or fabric of any kind, in which the wages or earnings which are recovered by the American workmen from the sale of these exportable products are not from 25 to 50 per cent. above the corresponding wages or earnings of the mechanics or artizans of Europe, or from ten to twenty times as much as the earnings of the peasants of Egypt, India, or China, who grow cotton and corn in competition with the Western Continent.

It is strange but true that the invention of an Englishman, Sir

Henry Bessemer, made the lessening charge possible for transporting the wheat of the Mississippi Valley to Great Britain, the effect being to deprive the English landlord of a large share of his rents and to render a readjustment of English and Irish tenures absolutely necessary to the further progress of British agriculture. Again, the joint invention of two other Englishmen, Gilchrist and Thomas, enabled Germany to convert her phosphoric ores of iron, previously of little use or value, into steel; and on that foundation her whole advance in the export of manufactures has been developed.

All that has thus far been said might seem to justify Lord Rosebery's phrase of "war of trade", but there is another aspect of the problem which remains to be considered. The proportion of the working population of the United States which is employed in any art of which a product of like kind could be imported in any important measure is very small, not 5 per cent. of all who are occupied for gain. Since American supremacy in iron was established there is practically nothing produced from the mines of the United States of which any corresponding product could be imported which would compete. America needs the ores of Cuba and Canada to mix with her own at the sea-coast furnaces. The textile arts and a very few other branches of industry are the only ones which would be subjected to any important change by an abatement of protective duties. If the materials of foreign origin which are necessary for the best use of the domestic products in the textile arts were admitted to the United States free of duty, the only import of similar fabrics from foreign countries would be of the hand-made fabrics, like laces and the best silks, which are woven on hand looms, or other goods which depend on the changes of fashion and fancy and not on their quality. The admission of the crude and partly-manufactured products which are necessary in the processes of American industry would doubtless enable the textile factories of the country to take a very much larger share in the increasing consumption of the world through exports. The American system of free trade may soon be extended on the methods of common sense, to the gradual but sure removal of all the duties on imports except those which may be maintained for revenue. American free trade will surely be so extended as soon as the country becomes aware of the fact that the worst obstruction to exports is the taxation of goods by duties on the imports, which it might secure in exchange for its products, especially from the great non-machine-using continents.

What proportion of the population is occupied in manufactures in

Great Britain is not within my knowledge. It must be very much larger than in the United States. But in this matter, again, it would doubtless appear upon analysis that the domestic traffic of Great Britain is very much greater than its foreign traffic, and that it may be widely extended. The manufacturing arts of which products are ever imported or exported are very limited in number. There are over three hundred and sixty titles in the United States census listed under the head of "Manufactures." It would be, however, difficult to find sixty, hardly more than thirty, of which any product of like kind could be imported at the present time, and that small proportion gives occupation to not exceeding 10 per cent., perhaps a much less proportion of those who are occupied in these branches of industry which are listed as manufactures. The same rule would be measurably true of the conditions of British manufactures. The lesser manufacturing and mechanic arts are of much greater importance in the building up of a State than are the great factories, mines, and furnaces. They tend to develop individual capacity and aptitude rather than to develop the operative or adjunct to the machine.

May it not, therefore, be held that if the war of tariffs of the United States, France, and Germany could be abated, these countries cooperating in mutual service, the exchanges and the benefits of commerce would vastly increase, each of the great manufacturing States assuming its true position in that kind of work best suited to its soil, climate, and conditions? If, again, Russia, now entering upon her great industrial progress and seeking to throw off the burden of militarism and to join in the establishment of peace, could be brought into this "zöllverein," as it might be called, the peace of the world would be assured. The abundant supply of all the wants of mankind in each country would be enhanced; the few privileged classes might have been sacrificed to the benefit of the many; but there would still remain the enormous demand of the rapidly developing continents which have not to any extent become manufacturing or mechanical States, to be supplied. It would be with respect to textiles as it has been with respect to iron and steel. In 1890, when the product of pig iron was in round figures 25,000,000 tons, I predicted that in the year 1900 40,000,000 tons would be required, and that it might be beyond the capacity of the then existing iron furnaces of the United States, Great Britain, and Germany combined to supply that demand. That prophecy was nearly justified. There is now a slight reversal of the demand on the abnormal rise in the value of coal, but at normal prices it is certain that 60,000,000 tons of iron will be insufficient to meet the wants of the world within ten or twenty years as it was that the supply of the year 1899 was barely sufficient.

Once the world is relieved from the blood tax of standing armies and the waste of warfare, the factories, workshops, mines, and furnaces of the five great manufacturing States, the United States, the United Kingdom, France, Germany, and Belgium combined would be insufficient to meet the increasing wants. On the other hand, the removal of obstructive taxes to the import of the crude and partly manufactured materials of the non-machine-using nations would so increase their power of purchase as to enable them to supply these wants.

It will be remarked that the unfortunate and causeless war between the United States and Great Britain in 1812 was fought by the Americans under the motto of "Free Trade and Sailors' Rights." The representatives of certain industries which had been pushed to an unwholesome success during that war and the embargo, then made the first effort to secure the adoption of a tariff based on the single motive of protection. This was resisted by the great merchants of New England, and at a meeting held in August, 1820, a committee of their number, including Nathan Appleton and Abbott Lawrence, who afterward became advocates of protection when they had been forced out of commerce into manufacturing, appointed Daniel Webster as their spokesman. He was then in the fullness of intellectual power. He denounced the effort to name this system an American system. He claimed for America the rights of American free trade. He said that the protection policy was being borrowed from Great Britain at the time when British statesmen were trying to overcome its evils. One paragraph from this great speech may well be quoted at this time:

> "To individuals, this policy is as injurious as it is to government. A system of artificial government protection leads the people to too much reliance on government. If left to their own choice of pursuits, they depend on their own skill and their own industry. But if government essentially affects their occupations by its systems of bounties and preferences, it is natural, when in distress, that they should call on government for relief. Hence a perpetual contest, carried on between the different interests of society. Agriculturists taxed to-day to sustain manufacturers—commerce taxed to-morrow to sustain agriculture—and then impositions, perhaps, on both manufactures and agriculture to support commerce. And when government has exhausted its invention in these modes of legislation it finds the result less favorable than the original and natural state and course of things. He could hardly conceive of anything worse than a policy which should place the great interests of his country in hostility to one another—a policy which should keep them in constant conflict, and bring them every year to fight their battles in the committee rooms of the House of Representatives at Washington."

Webster never gave up this principle. He became an advocate of protection, but in his later years he referred to his early declarations as those which were founded on principle and not on policy.

The policy of a tariff for revenue with incidental protection, which was established in the United States by Hamilton, sustained by Webster in his later years, and continued down to a recent period, has been completely changed in recent years to the theory of a tariff for protection with incidental revenue. This latter system has broken down in the house of its friends. The only force by which it is sustained at the present time is the fear of manufacturers that if they advocate the removal of duties on the crude or partly manufactured materials of foreign origin which are necessary in their own branches of industry, they may be subjected to a reduction of the very high duties on their own fabrics without gaining the relief from duties on the materials. The men who made the present system and who forced it upon the leaders in Congress are now divided among themselves, and are bringing about a division in the political parties. It may be hoped that the tariff question will soon cease to be a party measure in America. In that event the reform of the tariff may be accomplished by evolution, not by revolution; duties may be adjusted for revenue purposes, obstructive duties to crude materials entirely abated, and the open door offered to the great continents of Asia, Africa, South America, and Australia, for the free entry of the raw materials of which American manufacturers may make the most profitable use.

The great progress of the English-speaking people has been made in the past by free foreign commerce on the part of the United Kingdom and by American free trade on a continental scale within the United States. The United Kingdom of Great Britain and Ireland, the British colonies, and the British dependencies are now buying from the United States a fraction over fifty (50) per cent. of all the exports of the country. They are America's best customers. In the light of that fact one cannot yet imagine the grand conditions of commerce which will ensue when the English-speaking people shall be fully united by their own interests in mutual service, thus building up industries and insuring the common welfare wherever any branch of the English-speaking people may dwell, however they may slightly differ in their political institutions. When their forces are united for the protection of commerce, for the maintenance of open trade and open ports, no power existing and no union of the dynastic powers of Europe could venture to dispute their righteous and beneficent control.

AMERICAN TARIFF POLICY NOW SHUTTING THE OPEN DOOR.

By W. L. Saunders.

Mr. Saunders' article is a powerful counterpart to the preceding paper by Mr. Atkinson. As one shows how America's wonderful expansion has been based on unfettered internal commerce, the other uses a concrete living instance to show how it will be checked, by protectionist shackles, from the now necessary range abroad. Mr. Saunders makes a forceful plea for the revision of an outgrown system.—The Editors.

AT one time, about 1895-96, there appeared on the surface of things indications of prosperity. The entire world, the United States especially, had passed through a long period of depression, and every one was looking to see a turn towards better times. The writer met the late "Copper King," Mr. Marcus Daly, a self-made American of far-famed ability, and called his attention to this renewal of activity with the idea of getting his opinion on the subject. "Yes," said Mr. Daly, "the wheels of commerce are going around, but who in the devil is going to buy the stuff?"

And so it was. The renewed business was only temporary. The mills had begun to grind, and did produce at an active rate, but a limited market soon consumed the product, and the throttle was applied to the engines, reducing and in many cases stopping the pace. It was not until the latter part of 1897 that prosperity came in earnest, and in 1898 we realized that it had come to stay. This activity in business started first in Germany, antedating the rest of the world by more than one year. Great Britain caught the pace next. Then followed the United States with a longer and more permanent stride.

Prosperity is not a permanent thing. It acts like the ocean wave, now up and now down, subject to many controlling influences. The great and perhaps only barometer which we have to guide us is the iron and steel industry, and Mr. Carnegie has defined that as "either a prince or a pauper." Other lines of industry are subject to the same variations, but to a lesser degree. These conditions are especially apparent in a great manufacturing country, and with America the liability to fluctuate is also influenced by her vast agricultural interests. Twenty-five years ago, bad crops would have surely meant depression and ruin; but now that the United States has taken its place in the forefront of manufacturing countries, there exists a counter influence to crop dangers—provided there is an outlet other than the home markets for the products of American mills.

A nation that is subject to fluctuations in its business because of crop conditions is less stable than one which depends upon its manufactures. In one case there is no remedy, because we cannot govern the course of nature; the other appears to be within our control. Famines, which in olden times were looked upon as acts of God, and which still occur, are happily confined to agricultural countries only, such as India and Russia. But in the place of famine, manufacturing countries suffer the scourge of business depression, business failures, and financial ruin, just in proportion as the interests of the people are mismanaged. The United States has at several periods fallen a victim to mismanagement, and had it not been for the strength imparted by good crops, which have found markets throughout the world, it is very likely that the sufferings would have been greater. This is because, being an ambitious people, always striving to get rich, we naturally become extravagant, and during good times are "plungers." The danger is also great with us because of our inventive skill. We economize labor wherever we can, and in economizing labor we increase production. An American manufacturer who gets behind in orders does not hesitate to increase his plant, to work overtime, and to put in new machinery—or, in fact, to do anything that will enable him to produce all that he can sell. The stimulus to do this has been very acute during recent months because of the prevailing high prices; and every one is familiar with the frequent notices that have appeared of furnaces starting up, new enterprises, and additions to plants.

Mr. Thomas A. Edison recently completed a machine which he uses to make an important part of his phonograph. In exhibiting this he showed a somewhat complicated steel part, turned and finished, and produced at an expense of a few cents, because the labor employed was a girl who fed a light steel bar to the machine; and, as Mr. Edison said, 99 per cent. of the work is done by machinery. Turning to me he remarked: "It would have been money in my pocket had I never taken out a patent, but instead devoted all my time to the building of labor-saving machinery, because it is easier to get around a patent than it is to compete against a manufacturer who produces everything by machinery. If you have got your cost down to bed-rock you can supply the world's market." It is a well-known fact that the tremendous business built up by Mr. Carnegie is mainly the result of his enterprise and nerve in cutting down labor, scrapping his plant, no matter what it has cost him, provided he is able to replace it with improved labor-saving machinery. At one time in the Carnegie works there were 800 men employed in a department which produced 1,200 tons of metal per day. Improvements were made and the result is now that 1,500 tons per day is the product of 65 men. All this has resulted in a steadily increasing production at a reduced labor cost, and this brings us to the main question: "Who is going to buy the stuff?"

Statistics of our export trade show that during the fiscal year 1900 the value of United States goods exported was $1,394,186,371. Of these our production in iron and steel alone exported during the year was valued at $121,913,548, and the total exportation of domestic manufactures amounted to $432,284,366, being an increase of $92,692,220 over the preceding year, while in no earlier year has the increase amounted to as much as $50,000,000. Domestic manufactures formed 31.54 per cent. of the total exportation in 1890, against 28.13 per cent. in 1899, 26.87 per cent. in 1897, 23.14 per cent. in 1895, and 20.25 per cent. in 1885, 15 per cent. in 1870, and 12.76 per cent. in 1860. Exports of domestic manufactures in 1860 were $40,345,892, while the total exports, including imported goods re-exported in 1860, were $333,576,057, and in 1900 $1,394,186,371. Thus while the total exports of 1900 are four times as great as in 1860, those of manufactures alone are ten times as much as in 1860. In that year manufactures formed but 12.76 per cent. of total exports, while in 1900 they were 31 per cent. Even in the decade which ends in the year 1900 the growth in exports of manufactures has been equally striking. In 1891 the total exports amounted to $884,440,810 and those of manufactures alone to $168,927,315; the total exports for 1900 being thus but 50 per cent. in excess of 1891, while the exports of manufactures are more than 150 per cent. in excess of that year. A further analysis of the official figures given by the Bureau of Statistics shows that since the year 1860 our exports of manufactures have increased ten times, while those of Great Britain have increased but one and one-half times.

But let us not be intoxicated by these signs of prosperity. We must bear in mind that during the past two years our principal competitors, England and Germany, have been passing through a boom. In the latter part of the year 1899 I visited some of the shops in Germany and found them working day and night—the principal ones being from six months to one year behind in their orders. Prices had been put up and in some cases doubled, because, as some of them said, "We believe that now is the time to make money." At that time a letting took place of a large steam-engine plant, the award being given to an American manufacturer whose figures were a little more than one-half those of German or English builders. "You Americans need not run away with the idea that you are selling your machinery on the continent because it is so much better than ours," said a German merchant. "You are getting the business because our works cannot fill the orders; yours can, and at lower prices." Since this time things have changed. Germany and England, so far as steel and iron manufactures are concerned, are in a condition of depression. Mills are idle, or working on short time, and prices are down, so that we now have to face new conditions of competition. In addition to this, foreigners, and the Germans in particular, have caught on to our ideas, and are now in a better condition to challenge our right to foreign markets. As these lines are written reports are made showing a substantial falling off in our exports. Our exports of manufactures for January fell from $35,000,000 in 1900 to $32,000,000 in 1901. Our percentage of manufactures exported to total exports was nearly 31 per cent. in 1900, and so far this year it shows about 24.5 per cent.

During the month of February, 1901, a most unfortunate incident occurred. The Secretary of Treasury issued an order on February 14 imposing a countervailing duty of 30 to 40 per cent. upon sugar imported from Russia, and on February 16 following the Russian minister of Finance, M. de Witte, issued an order of reprisal against American imports of iron and steel products, adding thereto 30 per cent. increased duty, the order to take effect beginning March 1. The facts in the case are as follows:

A commercial treaty was entered into between the United States and Russia in 1832, by the terms of which it was intended that each party to the agreement should become the most favored nation in matters of tariff rates. Russia has three rates of tariff duties—minimum or conventional, general or normal, and maximum. The first is applied to those countries only which have commerical treaties with Russia, the second to imports of all other countries, and the third to such countries as discriminate against Russian commerce. The greatest difference between the rates of maximum and minimum tariff duties is 50 per cent. The United States, until the recent order, enjoyed the minimum rate, while now we have been placed in the category of nations which discriminate against Russian commerce, and are at the maximum rate.

In 1893 Russia negotiated a treaty with Germany and France by which special concessions were made on about 200 articles. At that time, and in accordance with the Russian interpretation of our treaty of 1832, equal concessions were extended to the United States. The United States did not agree to this interpretation of the treaty, on the ground, as it is supposed, that this government did not interpret the most favored nation clause to imply that we were bound to concede to Russia any tariff concessions that we might make to any other nation. Through the influence, and with the support of the administration, Mr. Kasson (special reciprocity commissioner) entered into negotiations looking to a new treaty. An agreement was arrived at which was sanctioned by the Russian cabinet, the details of which have not been published, but it may be authoritatively stated that this proposed treaty was of great importance to the United States. By its terms the minimum tariff was conceded by Russia to certain products when imported over the European frontier. Among these were products of cast iron and steel and all kinds of machinery, such as locomotives, boilers, rails, etc. Agricultural machinery was admitted free. It was further offered by Russia to permit importation free of duty through Eastern Siberia of a long list of articles such as salted meat, butter, fruit, earthen-ware, chemicals, canning and dyeing materials, wrought iron, iron and steel rails, sheet iron and steel, tin plate and manufactures of tin plate, cast iron, cast-iron products and boilers, tanks, bridges, nails, carriages, bicycles, tramways, railway cars, etc.; also a reduction of duties of from 10 to 50 per cent. on hops, wine, cheese, wooden-ware, zinc and lead, telephone and telegraph wires, etc. In consideration of these valuable concessions, the United States was expected to offer a reduction in tariff of from 10 to 20 per cent. on certain articles including flax, hemp, feathers, hides, and skins, and to abolish the countervailing duty on sugar, and also to maintain the present free list.

Pending these treaty negotiations and at the request of the State Department the Secretary of Treasury issued an order dated April 20, 1900, suspending the countervailing duty on Russian sugar, it being maintained by the Russian government that no bounty of any kind was paid to sugar producers. It must be understood here that the Dingley tariff law imposes a revenue tax of from 60 to 100 per cent., according to quality, on sugar imported into the United States, and that this law requires the Secretary of the Treasury to collect in addition thereto a countervailing duty equal to the bounty which any nation may give to its sugar producers. About the beginning of the year 1901 pressure was brought to bear on the Secretary of Treasury by personal representations and through delegations of American beet sugar producers, who are said to have acted at the instigation of the trust, to re-impose the countervailing duty on the ground that the importation of Russian sugar was a menace to the industry. The figures of importation do not appear to justify the claim made in the sugar interest. In 1900 our total imports of sugar were over $100,000,000 and of this sum Russia furnished $22,993. The Russian sugar laws were put in force in 1895. Since then our maximum importation has been $340,850 for one year, while the average for the five years since 1895 has not exceeded $75,000 per year. The United States consumes more than 2,000,000 tons of sugar per annum. The total exports of sugar from Russia since 1888 average but 90,000 tons per annum, out of her average annual production of 725,000 tons. In 1896 Russia exported 218,323 tons of sugar, in 1899 but 84,071 tons. These figures do not justify the alarm sounded in the sugar interests, and furthermore they discredit the theory that the Russian government encourages the exportation of sugar. If the Russian sugar law of 1895 may be construed as a bounty law, is it natural that the exportations should have decreased since then?

A hint was given out through the Treasury Department that the countervailing duty might be re-imposed and this drew to the subject the attention of manufacturers, who on investigation learned that the whole question was "One of facts and law." The law compelled the Secretary to impose this duty, provided the facts determined that Russia directly or indirectly gave a bounty. It was found that the Treasury Department had made no detailed investigation of the facts, that no one had gone into Russia for this purpose, and that certain statements which had been made to the department were asserted not to be the true facts by the Russian government. It was further learned that Russia had officially notified the Secretary of Treasury that any interpretation that Russian sugar receives a bounty would be considered as a discrimination against her commerce, and would make it imperative upon the Minister of Finance to impose the maximum duty on all manufactures of cast iron, iron and steel of every description, tools, and machinery of every kind. Manufacturers having interests at stake immediately proceeded to impress upon the secretary the dangers of the situation. The National Association of Manufacturers of America sent a representative to Washington, and appeals were made in personal interviews and by letters and telegrams, asking that time be given before a decision was reached, and attention was called to the following figures, showing our export trade with Russia:

Yrs.	Baltic and White Sea.	Black Sea.	Asiatic Russia.	Total.
1891	$7,260,115	$503,897	$161,580	$7,925,592
1892	5,385,627	1,313,208	120,200	6,819,035
1893	2,035,581	266,242	145,591	2,447,414
1894	6,273,623	553,852	163,855	6,991,330
1895	5,176,295	781,561	204,937	6,162,793
1896	6,298,427	1,198,223	568,002	8,064,652
1897	5,995,204	1,607,072	413,942	8,016,218
1898	6,251,202	1,084,880	618,015	7,954,097
1899	7,301,068	1,185,599	1,543,126	10,029,793
1900	6,196,892	1,241,425	3,050,102	10,488,419

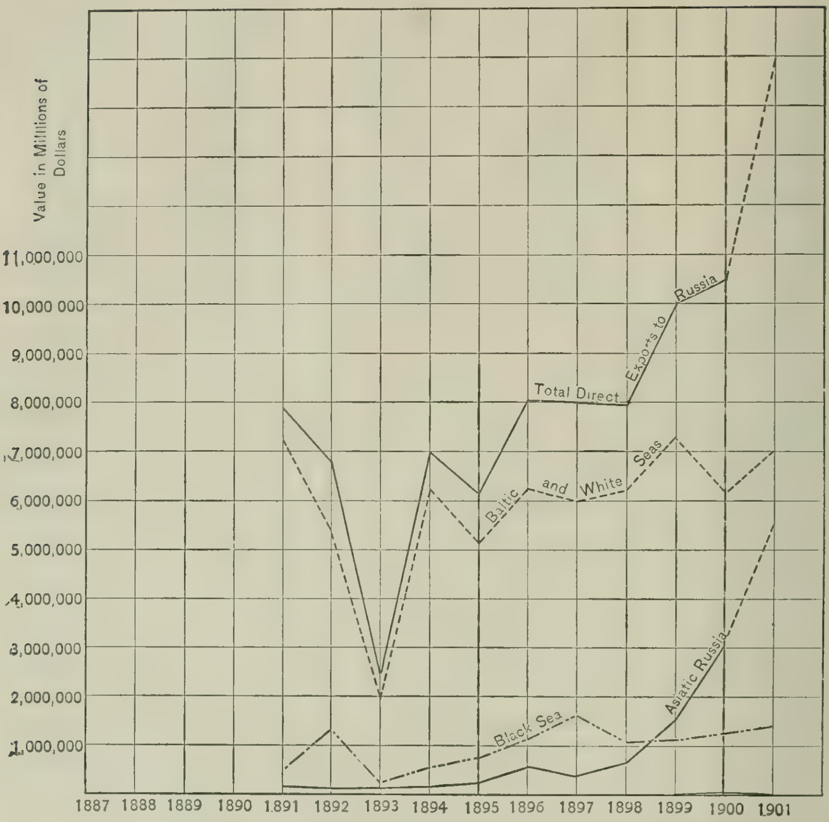
Details of the exports to Russia from the United States during the fiscal year ended June 30, 1899:

Agricultural implements	$910,947
Corn	116,039
Wheat flour	627,827
Other breadstuffs	4,285
Raw cotton	2,781,918
Iron and steel and manufactures of	3,529,052
Naval stores—rosin	294,517
Wood and manufactures of	27,876
All other articles	1,717,041
Total	$10,009,502

A letter was addressed to the Secretary of Treasury on Feb. 2 by the National Association of Manufacturers, calling attention to the difference of opinion as to the exact relations existing between the Russian government and the sugar interests, and the burden of responsibility thereby placed on the secretary in making a decision, and asking that a representative of the Government be appointed to visit Russia and to investigate all the facts, and that the sugar interest of the United States and the National Association of Manufacturers be each allowed to send a representative at their own expense to accompany the Government official to the end that these three investigators might mutually aid one another and agree upon a final and thoroughly informed report. On Feb. 14, however, the Secretary of the Treasury issued an order to all officers of customs directing assessment of additional duties of .50 rouble per pood on sugar testing not less than 99 per cent., .44 rouble per pood on sugar testing not less than 88 per cent., and .38 rouble per pood on sugar testing less than 88 per cent., as the "net amount of bounties paid or bestowed by Russia on the export of sugar."

Two days thereafter a cable from the United States Ambassador at St. Petersburg announced that Russia had retaliated as follows:

"An order of Russian Finance Minister directs additional tariff



AMERICAN TRADE WITH RUSSIA; EXPORTS OF ALL SORTS TO RUSSIA.

of 30 per cent., net, imposed upon articles included in paragraphs numbered 150, 151, 152, 153, 161 and section 2, and discriminating tariff upon American hardware, iron and steel boilers, pipes, forgings, castings, tools, gas and water meters, dynamos and sewing machines, of paragraph 167 of the Russian tariff laws, when such articles are of American manufacture. This includes motors and machinery of all kinds, to take effect March 1."

As the mischief has been done it is useless, perhaps, to dwell upon the reasons which induced Secretary Gage to act. His own words in explanation contain the following clause: *"In the present case the facts are involved and the conclusions to be drawn from them are correspondingly difficult."* The Secretary conferred with the Attorney General on the subject and the following statement has been made by a gentleman of high standing in Washington, who saw the Attorney General a few days before the Secretary's order was issued: "He (the Attorney General) stated to me as a lawyer that, in his opinion, a preponderance of evidence must be adduced showing that a bounty was paid or a grant made by Russia within the meaning of the Dingley tariff act before the Secretary was authorized to impose a countervailing duty; that the authority to enforce this provision of the act *must not rest on any doubtful facts, but that the evidence must be clear and convincing.*"

Briefly stated the facts are as follows: The Russian government, being paternal in its character, has absolute charge of all manufactures. Among these is sugar. It levies an internal revenue tax on all sugar ground for consumption in Russia. The government fixes a certain limit above which no sugar shall be ground for home con-

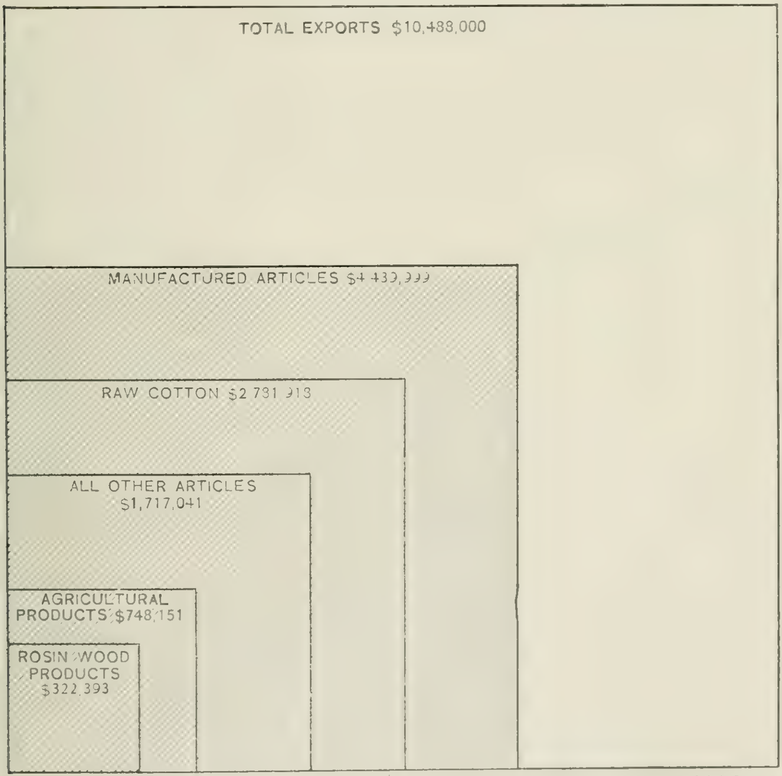


CHART SHOWING RELATIVE PROPORTIONS OF MATERIALS EXPORTED FROM THE U. S. TO RUSSIA
Year ending June 30, 1899

sumption. Each factory is assigned its individual allotment of the whole amount which it may grind for government use to be consumed in Russia. Beyond this allotment the factory may grind all the sugar it pleases, but it cannot sell the product in Russia. The government keeps about 10,000 tons on hand as a surplus, so that in the event that sugar grinders combine to force up the price of sugar the Russian government can dump its surplus stock on the market and force the price down. Such being the fact in Russia, the only possible outlet for a surplus production of sugar is export.

Sugar which is exported pays no excise tax, or if an excise tax has been paid it is refunded on exportation. This brings us to the first question.

1. Does the absence of an excise tax constitute a bounty?

If we define a bounty as a premium or reward, something which enables the producer to lower the cost of the article, then the absence of a tax is not a bounty. Should the government refund on exportation a *larger amount* than the actual internal tax this would be a bounty; but the government refunds exactly the tax paid, and this can no more be construed a bounty than the act of the United States government in refunding, on exportation, duties which were collected on importation.

2. Do not the Russian laws, which have been established for the purpose of limiting the production of sugar, encourage exportation and thus create an indirect bounty?

Let us first consider the purpose which Russia may have had in mind in establishing such laws. It is difficult in any country to determine accurately what the beet-sugar crop from year to year will amount to. It is especially difficult in Russia because the climate of Russia is so uncertain and variable and the crops are so dependent upon the climate that planters cannot foresee results. The population of Russia is in the main moujiks or poor people. There are 100,000,000 moujiks and 30,000,000 educated people in Russia. Now, if times are good, the poor people consume a great deal of sugar, and the reverse is true during hard times. Statistics show that the consumption of sugar falls off very materially during famine years.

In order to insure a sufficient supply of sugar in advance the government makes an estimate and allots a definite production; but to insure against overproduction and demoralization of prices this production is limited. Now we see that the Russian government protects both the sugar grower and manufacturer and through this protection the manufacturer is insured a good price for his home product. If he attempts to impose upon the consumer by running up the price too far, the hand of the government is shown in dumping the surplus stock upon the market and thus bringing prices down. As a matter of fact, the Russian consumer pays nearly seven cents per pound for sugar which is sold at the same time in the English markets for four cents.

London is an important market for Russian sugar and in 1896 the figures show that the price in Russia was £30.30 per ton, while in London this sugar was sold at £11 per ton. After making allowances for the excise duty on the home product, there still remains an apparent loss of £8.6 per ton exported. This does not appear to be an encouragement for exportation, and were it not for the very profitable business done at home Russian manufacturers would be ruined by a large export business.

In Russia the government fixes the maximum price by law, while in the United States precisely similar results are obtained by the operation of our tariff laws. Should our sugar trust attempt to put up prices of sugar beyond a certain point, foreign sugar would come in and operate precisely as the Russian reserve does—to bring prices down. The Russian sugar merchant makes so much money at home that he can afford to sell even at a loss for exportation, and this is exactly what takes place in the United States. If this is a bounty, then the products of the United States are in danger of being subjected to countervailing duties from foreign governments. But there is a difference between the Russian laws and ours in that in Russia the operation of the law has shown that the maximum price is gradually reduced, and thus an advantage is given to consumers. The following are the figures which show this:

MAXIMUM PRICES OF SUGAR IN RUSSIA. (Rubles per Pood.)

For 1895-6	4.75 (before 1 Jan.), 5.00 (after 1 Jan.)
For 1896-7	4.65 (before 1 Jan.), 4.90 (after 1 Jan.)
For 1897-8	4.60 (before 1 Jan.), 4.60 (after 1 Jan.)
For 1898-9	4.50 (before 1 Jan.), 4.50 (after 1 Jan.)

It is therefore seen from the above that the main object of the Russian law is to regulate the production of the sugar in such a way as not to encourage an oversupply in excess of the yearly increase of consumption in the home market, and at the same time to secure for the consumer a reasonable and constantly decreasing price, made possible by improvements made from year to year in the industry.

Prior to 1887 Russia paid a bounty of about one cent per pound on sugar exported; but in that year further payment of bounty was stopped on the ground that the government "did not desire to supply foreign markets with a cheap sugar at the expense of the imperial treasury, it being determined that bounties could be omitted without bringing the sugar industry to a critical situation."

Russian refineries have certain arrangements among themselves by which one refiner sells to another his right to supply a certain quota of sugar to the home market. A refiner near a seaport sells his home right to one in the interior and exports his stock, the difference being made up by exchange among themselves of government certificates of exportation, which are said to be subject to barter and sale in Russia. This is an internal private business arrangement among the merchants. The government has no more to do with it than has the United States government with a combination among steel merchants to put up the price of steel rails, and doing this to buy out some small producer who agrees not to sell in the home market but to ship his product abroad. The bills of lading or export certificates which are sold in Russia are of no more consequence than our using bills of exchange instead of shipments of merchandise in business transactions.*

The facts do not appear to sustain the contention that a bounty is paid. The Russian system is certainly different from that in all other countries where bounties are known to exist. The government does not give directly or indirectly anything to the producer which enables him to reduce the cost of the product. The quantity sold at the home market is fixed and the price is profitable; hence every pound exported reduces the profit by the loss in its sale. Were it physically possible, Russia would produce only enough for the home market and no more. What definition of bounty can be applied to this case? It is on the contrary really the American system improved. Suppose all countries should agree to abolish bounties; what would Russia be expected to do and what would we do in the United States.

It is interesting to note here that in the year 1898-99 the Russian government purchased from the Maryland Steel Co. 120,000 tons of steel rails for use on the Trans-Siberian Railway, the price being $17.75 per ton, at this time ruling prices at home were from $33 to $35 per ton. The iron from which this steel was made was produced from ore imported from Cuba, and it is a matter of record that the steel company at Sparrows Point recovered on the exportation of these rails 99 per cent. of the duty which had been paid on the ore.

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* A consular report made at the request of the Treasury Department and published in the Congressional Record states:

"The manufacturer who ceded his right receives from the manufacturer who acquired the right the price per pood agreed upon between them, which is usually determined by the difference existing at the moment between the price obtainable for sugar on the home market and the price obtainable by sale abroad. This is what is termed a transfer. Dependent on the fluctuations in price of sand sugar in Russia, and abroad, the price of these transfers also varies; therefore the person who sells the transfer (the right of issue into the home market) charges several kopecks more than the difference mentioned above. This is done on account of the risk that is taken that sugar prices abroad may fall and also for the trouble involved in exporting, etc."

Efforts have been made to belittle our trade with Russia. It is doubtful that any of the figures published represent the true value of Russian business. The long time credits there and the lack of knowledge which American exporters have of business conditions have developed an indirect business with Russia, principally through Germany. German merchants buy American goods and re-ship into Russia. They are closer at hand and have a better knowledge of the country; besides, many of them have direct representatives in Russia, or at least are represented through the banks. One exporter in New York, Markt & Co., do a business of about $750,000 per annum there, a large proportion of it going through German merchants. Markt & Co. say that since the Secretary's order was issued they have received cancellations of orders in amount greater than the total annual imports of Russian sugar. Even in Savannah, Ga., an order for 40,000 barrels of resin (not affected by M. De Witte's reprisals) has been countermanded because of this trouble. These are specific cases which indicate a far-reaching effect in this unfortunate affair. Coming just at this time, when a billion-dollar steel trust has been organized, it excites thoughts of reprisal among other nations and unless the United States Senate gives speedy relief by passing some of the reciprocity treaties, our exports will be seriously affected, if not ruined. Germany, close at hand and jealous of the inroads made by American exporters, is now on a more favorable tariff basis with Russia on a very large number of articles for which American manufacturers have at great expense built up a market. German exports to Russia are now over $100,000,000 in manufactured goods alone. Even if it be true, as claimed by our Treasury Department, that but a few million dollars worth of export business has been affected by M. De Witte's order, see what possibilities were before us.

In a remarkable book on trade treaties by Dr. Vosperg-Rekow Russia is referred to as the promised land for Germany's manufacturers and exporters. He goes on to say: "Our commercial relations with the empire are already very intimate; 12 per cent. of our imports come from Russia, while she takes one-tenth of all of our exports. The business transactions with Russia are among our most profitable; we sell her goods at high price and take hardly anything but cereals and raw materials in return. Therefore we must be extremely careful to retain this good customer. America is not nearly as profitable a customer to us as Russia is, and should we adopt measures to shut out foreign grain we must spare Russia, even though we differentiate against America and other countries."

We cannot always sell unless we also buy. The commercial position of the United States would be weakened, not strengthened, by a policy which looks to receive money alone in payment for its products. Unless the purchaser in a foreign country is given a chance to sell us something in return, the time will come when he will not be able to purchase anything. All trade to be permanent must be reciprocative. One of the drawbacks at present in shipping American products abroad is that there is no opportunity to get a return cargo. Hence, in order to maintain the permanence of our present position as a great exporter, we must labor to be a great importer as well; and it would seem to be clear that the first step in this direction is to lower the tariff on raw materials.

M. de Witte, who is perhaps the ablest statesman in Europe today, is a protectionist of no uncertain type. At the age of forty-four he fought a tariff war with Germany to a successful issue, and Mr. Henry Norman, in the March number of *Scribner's Magazine,* says: "Since that time his high-tariff neighbors have taken good care to give him no grounds for reprisals." "History shows," said M. de Witte, "that exclusively agricultural countries, even when they are politically independent and internationally powerful, are economically restricted to the *rôle* of tributary colonists. . . . . Like all other methods of action, protection should only be regarded as a temporary measure, in force until the time comes when its object is reached." "I believe," said President Garfield, "in that protection which leads to free trade."

If the bars of protection serve as they do now in the case of this Russian business, as dams to obstruct the flow of our products into foreign fields, then let us take them down. Mr. Blaine, a disciple of protection, evidently saw clearly that reciprocity was essential to the maintenance and integrity of protection; hence he coupled it with his protection idea. If protection has built up the United States to its present position, and if to be a great manufacturing country is desirable in the interests of the whole people, then it is as important now to protect the manufacturers by open doors as it was to build them up by a tariff which has now become useless and which has begun to be hurtful.

Oil Wells at Bibi Eibat Photo by Dr. E. O. Hovey.

ENGINEERING OPPORTUNITIES IN THE RUSSIAN EMPIRE.

By Alexander Hume Ford.

Mr. Ford's series of articles on Russia's marvellous industrial expansion and mechanical needs began in the February issue of THE ENGINEERING MAGAZINE. They were, of course, prepared before M. de Witte's tariff measures, directed against the United States and Germany, had attracted all eyes to the huge prize which Russia offered to those manufacturers whose home tariff policy does not debar them from the competition. This impartial measure of the value of the opportunity, obtained by the personal observation of a competent authority, gains yet greater value from the recent course of events. Mr. Ford, as an unbiassed American engineering traveller, writing before there was any menace of the closure of Russian markets to protectionist countries, irresistibly reinforces Mr. Saunders' paper preceding. He confirms from within what Mr. Saunders discerns from without—the almost boundless opening which Russia affords for an unfettered commerce.—THE EDITORS.

THE men in America to-day who best understand the mechanical needs of Russia, and control the export of manufactured articles and machinery, are mostly Russian or ex-Russian subjects, many of them graduates of the leading Slavonic universities, who have emigrated to the United States on account of the severe persecutions of the all powerful Orthodox Greek Church. For centuries the traders and merchants of Russia have been either foreigners or native born Jews; the latter, accustomed for generations to guard the secrets of their trade, are not now disposed to kill the goose of the golden egg by laying bare to every American the knowledge which is theirs by right of inheritance.

With friends and relatives in every center of business activity in Russia as agents, and co-religionists in the cabinet of the Tzar; with the Trans-Siberian and other railways largely under the direction of Hebrew architects and constructors; with the government looking to

OIL REFINERY OF NOBEL BROS. SYNDICATE AT PETROLIA, NEAR BAKU. PETROLEUM IS RUSSIA'S MOST IMPORTANT FUEL.
Photo by Dr. E. O. Hovey.

the same race to supply its financial advisors, even turning over to them the Russo-Chinese Bank, now all powerful from St. Petersburg to the Pacific—those of this tirelessly energetic people whom Russia seeks to exile from her domains flock to Anglo-Saxon shores, where, no longer poor and despised, they have formed a great clearing house, through which America transacts the enormous business being built up between the two nations. In England, with the great Rothschild as patron, the services of this people have proved valuable to every worker in the machine shops of Great Britain, so that owing to the irrepressibility of his nature, it has been possible for the Russian Jew in exile not only to better his own condition and uplift himself to heights he little dreamed of a few years ago, but to bring the great Anglo-Saxon and Slavonic nations into closer bonds, much to the lasting advantage of both, and of himself.

In fact, until quite recently the foreign commerce of Russia was entirely controlled by comparatively few foreigners who spoke her language and held special privileges from the Tzar's government. But now the work accomplished by these foreign merchants, including generations of Englishmen who have represented British commercial houses in Russia, the business results of which are naturally guarded as secrets of the trade—threatens to become the property of all; for after half a century of antipathy toward the Briton, the jealous Slav has sent forth hordes of lowly exiles, who have found it to their commercial interest to act as peacemakers, so that once more, as before the Crimean war, the Anglo-Saxon is pouring into Russia on business bent, and Russia is eagerly reaching hands across the sea to both America and Great Britain.

The Imperial Government, to encourage mutual commerce, is about to remove all tariffs from iron, machinery, and other material necessary for building steamships, so that Russians can construct the boats necessary for the desired direct lines from Odessa and St. Petersburg to New York, favored by the Tzar, but which the Americans have been slow in materialising; so that, after all, the Russo-American Steamship Company promises to be a Russian-owned and subsidised affair, while the steamers which are to carry Siberian chilled beef and dairy products to London will be Russian, and are already promised a liberal subsidy as soon as they are placed in commission. The dairy exports of Russia have risen in a few years from less than $100,000 in value to over $20,000,000, so that they now need larger markets than little Denmark, while from England and America return cargoes of dairy and farm machinery will be encouraged. But it is not necessary to go inland to begin observations as to what Russia needs from without. Almost my first landing in the Russian Empire was upon a two-million-dollar pier, constructed in part with and of material from both America and England.

Piled up in great mountains of packing cases, or lying loosely about on the vast pier, were pieces of machinery, locomotives, rails, hand cars, boilers, steam rollers, all bearing the stamp of some well

OIL TANK STEAMER MOÏSEÏ, ON THE CASPIAN AT CHORNY GOROD, THE "BLACK CITY," NEAR BAKU.

Photo by Dr. E. O. Hovey

known American house, while on the same pier were great sections of steel barges made in Scotland, for use on Russian waterways.

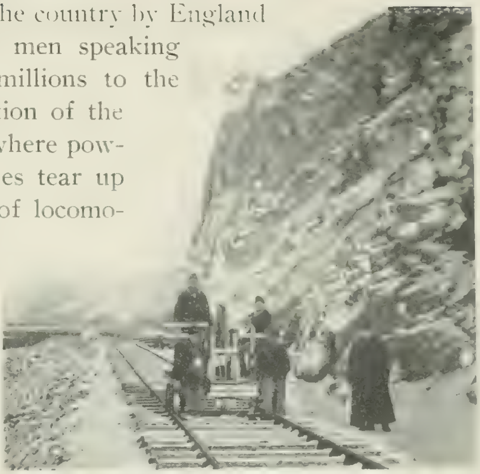
After visiting other Russian ports, I lost entirely my surprise at invariably witnessing the predominance of Anglo-Saxon enterprise in the Tzar's domains. Each part of the Empire seems to require different kinds of machinery and supplies. At Odessa and Azof seaports, it is a common sight to observe miles of Chicago-made reapers and other agricultural implements awaiting shipment inland, while at Batum is unloaded machinery for the oil wells, the tubing for the pipe lines being constructed by a Russo-American factory in Russia.

In the west, machinery for electrical plants, railway material, and mill machinery find their way to Riga and St. Petersburg, while in the east the result of the Tzar's ukase abolishing all tariffs on materials entering Pacific ports of Russia has had the desired effect of vastly increasing Siberia's commerce with America. Through these Siberian ports passed the rails, ties, locomotives, and equipment of the Manchurian and Eastern section of the Trans-Siberian Railway, to say nothing of the iron work for bridges and material for constructing and supplying new cities and workshops—all of which must be done over again at a cost of many millions; for the railroad where completed has been torn up by the Manchus, equipment destroyed, and workshops burned. In fact, from one end of Russia to the other, a great field is opening up for the engineer who can explain to his Russian confrères and others the best methods of utilizing the com-

AN EXPRESS TRAIN AT BAKU STATION.

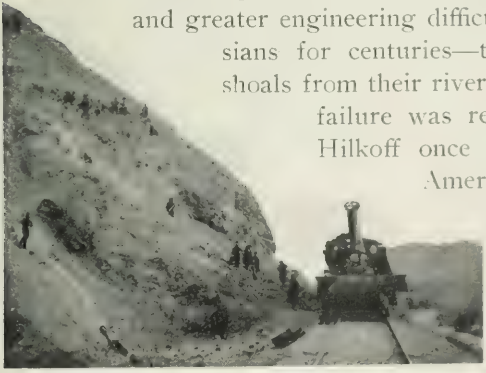
By courtesy of Dr. E. O. Hovey

plicated machinery sent into the country by England and America. A few such men speaking Russian could have saved millions to the Government in the construction of the Manchurian Railway alone, where powerful American mogul engines tear up the light rails, while scores of locomotives, built with fireboxes for burning wood, lie idle by the roadside in a country where even crossties must be imported from across the Pacific. Prince Hilkoff, the head of all railways and means of water communication in Russia, best understands the remarkable faculty possessed by the American engineer for designing and the English for carrying out those designs; for the prince spent several years in America as an employee of the Pennsylvania Railroad, studying Yankee engineering methods.



A RUSSIAN-MADE HAND CAR.

After the Russian and other European engineers had failed in their efforts to supply any effectual means of keeping open in winter the ice-clad ports of Russia, a commission was sent to America to look into the system in use on the Great Lakes, with the result that within a year or two after the report of the commission, duplicates of the Great Lake ice-breakers were ordered from English ship-builders, and now keep ice-free the year round the Baltic and Pacific ports of Russia, to say nothing of the Arctic harbors and the waters of Lake Baikal, upon which experiments are being made. Another and greater engineering difficulty has confronted the Russians for centuries—the removal of the shifting shoals from their rivers and harbors. Failure after failure was reported, until at last Prince Hilkoff once more bethought himself of American methods, and Lindon W. Bates, of Chicago, was induced to visit the chief rivers and harbors of Russia, for the purpose of making a private report to the government



ENGINE BUILT AT SIBERIAN WORKS

as to what he considers the best method of accomplishing the desired results.

Mr. Bates made his report, returned to Chicago, and drew the plans for the largest dredger ever constructed. It was to excavate a channel 14 feet deep and 80 feet wide at one cutting, and to burn naphtha at the rate of 1,200 gallons an hour. The plans were given to an Anglo-Belgian firm, which proved so successful in carrying them out, that the "American dredge" became famous all over Europe almost upon its completion. Representatives from nearly every government came to see this wonderful boat, propelled by electricity, tear its way along the bed of the river, digging a channel as it passed. From Australia, India, and other countries came orders for duplicates, and Russia, having already spent over $30,000,000 on her waterways in the last few years, has recently given an American a $7,000,000 contract to deepen her Pacific Ocean harbors, and is ready to order a still larger "American dredge" and many smaller ones. If these craft are hereafter built in Russia, the material will doubtless be allowed to enter duty-free, and no doubt many Americans and English engineers and electricians will be needed to guide those who build and operate the dredgers; for in spite of the fact that the government has established technical schools and engineering colleges in every part of the Empire, the graduates of which hold military rank and must be

A LARGE BUCKET DREDGE WITH SPOUT DISCHARGE AT WORK ON THE ALEXANDER III. CANAL.

employed before any outsiders are called in, there are certain positions open only to those who have studied in that particular branch.

To secure a great factory and mechanical plant in Russia, the government gave the Westinghouse Company an enormous order to supply passenger and freight trains in the Empire with their air brakes, upon condition that they would manufacture them in Russia. It was, of course, necessary to put only experienced men at the heads of all departments, and so it was that over a hundred expert English and American engineers and workers find lucrative employment in St. Petersburg, where the Westinghouse works are located. At first it was necessary to import the rough castings, and, of course, all of the machinery for equipping the plant. Now, however, everything is made in Russia.

CITY OF ZLATOOUST. THE OFFICIAL BEGINNING POINT OF THE SIBERIAN RAILWAY. CENTER OF THE SOUTHERN URAL MINING REGION, AND SEAT OF A LARGE IRON FOUNDRY

By courtesy of Dr. F. O. Hovey

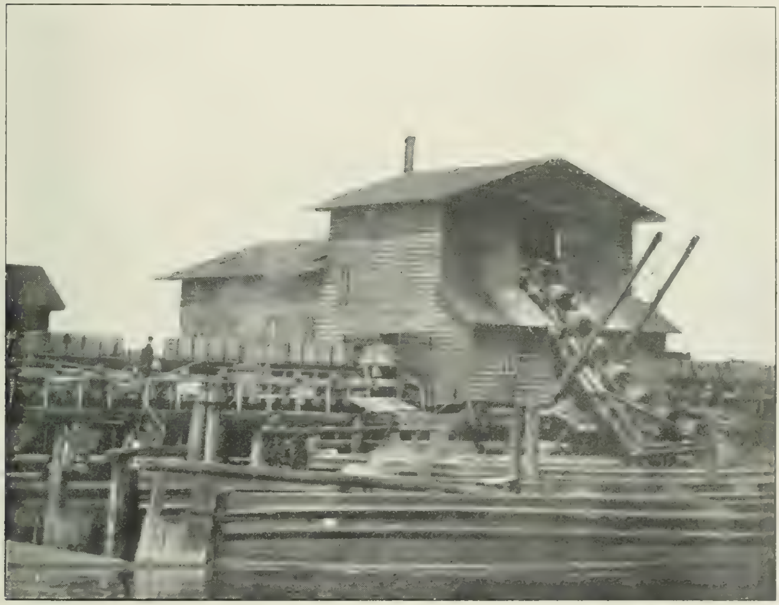
It is in this way that the Tzar is seeking to make Russia industrially independent of other nations. Another American company has been induced, by a promise of paying orders, to erect locomotive workshops in Russia. The equipment, of course, will be imported, and American mechanics will be in charge of the shops. By degrees, Russia will become a manufacturing country, but it will be many years before she will be able to compete with the older manufacturing nations, which, in the meantime, should reap a golden harvest fitting her for the position she desires to hold as their competitor.

It should not be forgotten that while America and Russia are the only two great nations exporting more than they import, and America is seemingly the most prosperous, she has not the wonderful undeveloped resources possessed by Russia, the stupendous natural system of inland waterways, nor the vast extent of territory. It will doubtless surprise many to learn that Russia is a greater cattle and sheep-raising country than the United States, and needs machinery for her tanneries and leather-working factories, which are constantly being erected. Soon there must begin to grow a demand in Russia for all the mechanical appliances necessary to well-equipped modern stock yards and packing establishments. Someone must teach the Russians how to conduct this great plant. Some years ago, an Englishman built and equipped for the Tzar a sugar refinery. It is now, although one of the many sugar refineries, but one of the few in all Russia perfectly equipped with modern machinery, including electric motors and turbines for making use of water power, but it is a sign of the times.

THE DEMIDOFF IRON MINES AT NIJNI TAGHILSK, SHOWING GENERAL CHARACTER AND EXTENT OF WORKINGS.

By courtesy of E. O. Hovey, Esq.

Sugar making has become in Russia a protected monopoly, paying enormous profits and utilizing the product of over one million acres of beets. Many of these plantations are irrigated, and the various makes of pumping windmills are coming into use. Russia is also fast becoming a great manufacturer of cotton goods; but it should not be forgotten by engineering enthusiasts that, owing to the fact that there is a plentiful supply of labor, wages are absurdly low, while a high tariff so protects the manufacturer that he can afford to buy discarded, antiquated machinery from mills and factories of other nations, and even then compete with them in the Russian market. With the inpouring of foreign capital, however, which seems to have begun, many new industries are being started, and to remain in the field the old companies will have to purchase up-to-date equipment and employ experts to install and superintend the working of the new plants.



A RUSSIAN GRAIN ELEVATOR. MECHANICAL CONVEYOR TAKING GRAIN FROM CANAL BARGES.

But it is not the industrial enterprises which mostly interest the Anglo-Saxon engineer and mechanical genius. Russia is awakening to the uses of electricity; various cities, from Odessa on the Black Sea to Vladivostok on the Pacific, are inviting estimates on trolley systems and electric lighting. I have stopped at Russian hotels which have ordered out the flimsy French incandescent plant, to be replaced by the more reliable up-to-date American system. Even the Franco Alliance does not guarantee favoritism. Only recently, the city of

Odessa gave an American firm an order for the piping for the construction of her sewerage system. The French Ambassador at St. Petersburg protested and insisted that the contract should be annulled and then awarded to French firms; but in spite of the request of the Russian Minister, this Odessa refused to do. On another occasion, the American consul held up bids for rail until he could cable American firms, one of which secured the order.

There is no prejudice against the American drummer in Russia, although he is taxed fully as much as others. Every foreign firm doing business in Russia must pay an annual tax of $750, unless it establishes a branch factory on Russian soil, when the tax is reduced two-thirds. In fact, in every way are foreigners induced to aid in the development of the great Russian empire. Last summer, in Siberia. I met young American drummers (who had learned Russian) enthusiastic over the possibilities of invading that part of Russia. This year the Siberian merchants would exclude all competing American products and manufactures did not the strong hand of the government prevent. While at the other end of the line, in Europe, quite recently I heard it stated by more than one Russian official that the American colony in St. Petersburg had grown within a few years from a handful to more than a thousand in number, and the cry is "Still they come."

The English, following the example of the Germans, have gone about the work of securing Russian orders in a businesslike manner. They publish a Russian business paper at Moscow, and give purchasers six months or a year in which to settle their bills. American business men seem content to rely on the exertions of the various consular agents, for it is only through the influence of their Minister at St. Petersburg that any progress has been made towards holding the proposed machinery exhibit in St. Petersburg next summer, and now that the likelihood of an International Exposition at St. Petersburg in 1904 grows, the two may be merged. With the exception of France, other foreign nations seem to have overlooked the importance of Russian fairs, especially that of Nijni Novgorod, as means of introducing what they have to sell. At Nijni Novgorod more than $40,000,000 worth of material still change hands annually; here the starosta, or chief of the village artel, comes to buy the supply of raw material on which the moujiks will work during the long winter days. Tons of iron, boilers, and various kinds of machinery are sold here; turning lathes, and such machinery as the peasants can use in common, are in demand; machinery for cutting shingles, axe handles, and wood-turning tools would find a ready sale; but the Russian insists upon seeing a piece of machinery work before he will purchase, which is one reason that over one hundred and fifty American firms have combined in southern Russia to aid each other in introducing the mechanical devices of their country.

German manufacturers have long since seen the wisdom of such co-operative methods, and further, they educate their young men to go forth and represent certain lines of goods. In a similar manner, American and English manufacturers of machinery would find it to their interest to send out engineers capable not only of explaining the working of various kinds of machinery, but able also to prepare plans for the construction of bridges, factories, electric plants, trolleys, water works, drainage, sewers, gas pipe, or other systems or improvement which may be desired by individuals or civic bodies; for it must not be lost sight of for a moment that Russia is spending every cent she can possibly borrow in developing her magnificent resources. New and mighty canals are to be cut, rivers and harbors deepened, arid lands irrigated, forests cleared and waste lands reclaimed; cities, villages and workshops are being built, colonies are planted in new localities, where modern systems of drainage and agriculture are being introduced.

THE CITY OF NIJNI NOVGOROD. A CENTER OF RUSSIAN COMMERCIAL ACTIVITY.

By courtesy of Dr. E. O. Hovey

Not only is all Russia alive to the stupendous evolution taking place, but France, Germany, and Belgium are investing all the money they can spare in Russian factories and other enterprises. Even in St. Petersburg many millions are raised yearly for the exploitation of coal, iron, gold, and copper mines in the Urals and beyond. For these,

MANGANESE MINING BY PRIMITIVE METHODS, STILL IN USE IN PARTS OF RUSSIA.

new and efficient machinery is needed. Many Americans are interested with these Russian investors, and both English and American engineers are even now prospecting almost everywhere in the Empire, where it is probable any mineral is to be found.

Additional chance of employment is opening up to the Anglo-

WASHING PLANT OF THE MIASK GOLD PLACERS.

Photo by Dr. E. O. Hovey

RIFFLES OF THE MIASK GOLD-WASHING PLANT.
Photo by Charles Palache, Esq.

Saxon engineer, who is willing to superintend the erection and fitting of the flour mills, whiskey stills, canning machinery, saw mills, mining machinery, electric plants, and steel frame buildings, which America is sending over in ever increasing quantities.

I have seen simple machinery for mills and mines lie idle for months in Asiatic Russia, because no one could be found who knew how to superintend its erection. In fact, Russia seems to stand to-day where America stood half a century ago, on the threshold of an industrial prosperity and development which must soon awe the world by its rapid and stupendous growth. It is here that the Goulds, Rockefellers, Huntingtons, Carnegies, and Flaglers of the future will spring up and become all powerful.

The government is setting an example in erecting the most modern and perfectly equipped machine shops the world has yet known. This example she induces private individuals to follow by assisting with vast loans of money those who embark in new enterprises; and one by one as they are started, the bars are put up against foreign competition. Already the almost prohibitive tariff of $3 a ton on iron has

GOLD QUARTZ MILL OF WONLIARLIARSKY CO., ARCHANGEL MICHAEL MINE, NEAR TSCHELIABINSK, EASTERN URALS.
Photo by Charles Palache, Esq.

GENERAL VIEW OF DIGGINGS, ILMENSKI GOLD PLACER NEAR MIASK, EASTERN URALS.
By courtesy of Dr. E. O. Hovey.

caused many foreign workshops to seek sites in Russia where 90,000,000 peasants, idle for six months of the year, gladly work for a pittance, while the government guarantees that they shall not strike. In districts where coal is scarce, if it is necessary for the welfare of the fondled industries, the tariff is remitted, so that at present both American and English coal finds its way into the Tzar's domain.

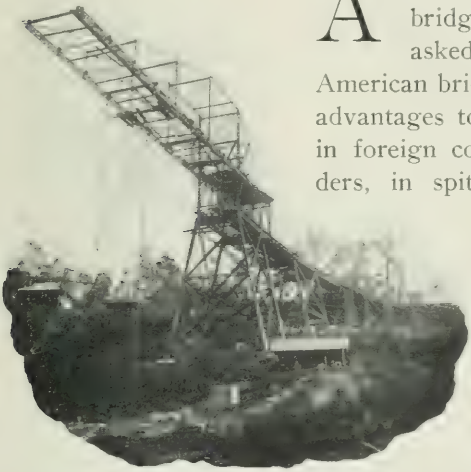
Russia will make many sacrifices to avoid war, which would interfere with, if not put a complete stop to, her internal development. Least of all does she desire the ill will of America. She much prefers Anglo-Saxon yellow gold to its cold lead. Her masterful diplomats may be trusted to make any concession likely to stimulate Anglo-Saxon activity in the way of investing in Russian industrial enterprises, so that her two greatest rivals, England and America, may become so deeply interested financially in the welfare of the Russian Empire that they will be compelled to force her development as a means of protecting their pockets.

This seems to be the game Russia is forcing us to play with her, and as it is seemingly the only one at which all can win, it is not likely that she will find her associates backward in playing their hands.

EUROPEAN AND AMERICAN BRIDGE-BUILDING PRACTICE.

By Thomas Curtis Clarke.

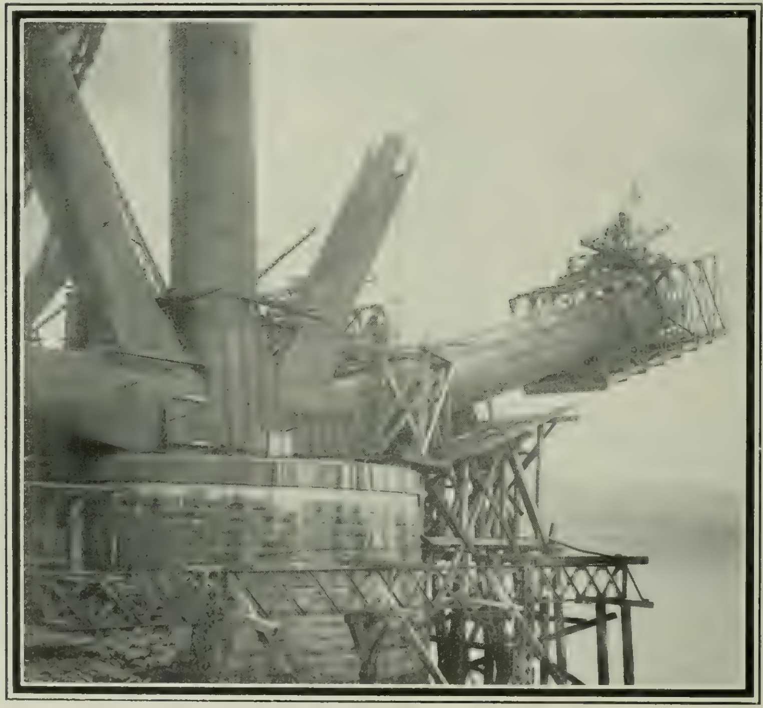
Exactly ten years ago, under the title "The Greatest Bridge in the World," Mr. Clarke contributed to the initial number of THE ENGINEERING MAGAZINE a study of Sir John Fowler and Sir Benjamin Baker's great Forth Bridge. That remains to-day unrivalled in majesty and boldness of conception. Neither Europe nor America has been called upon to carry out a work of similar size. But in the demands which have been made, for thorough work under difficult conditions and with the maximum economy of time and money, America has passed her older teachers and rivals and challenged the attention of the world. Mr. Clarke's present review is concerned with the perfection of mechanical methods by which this has been accomplished.—THE EDITORS



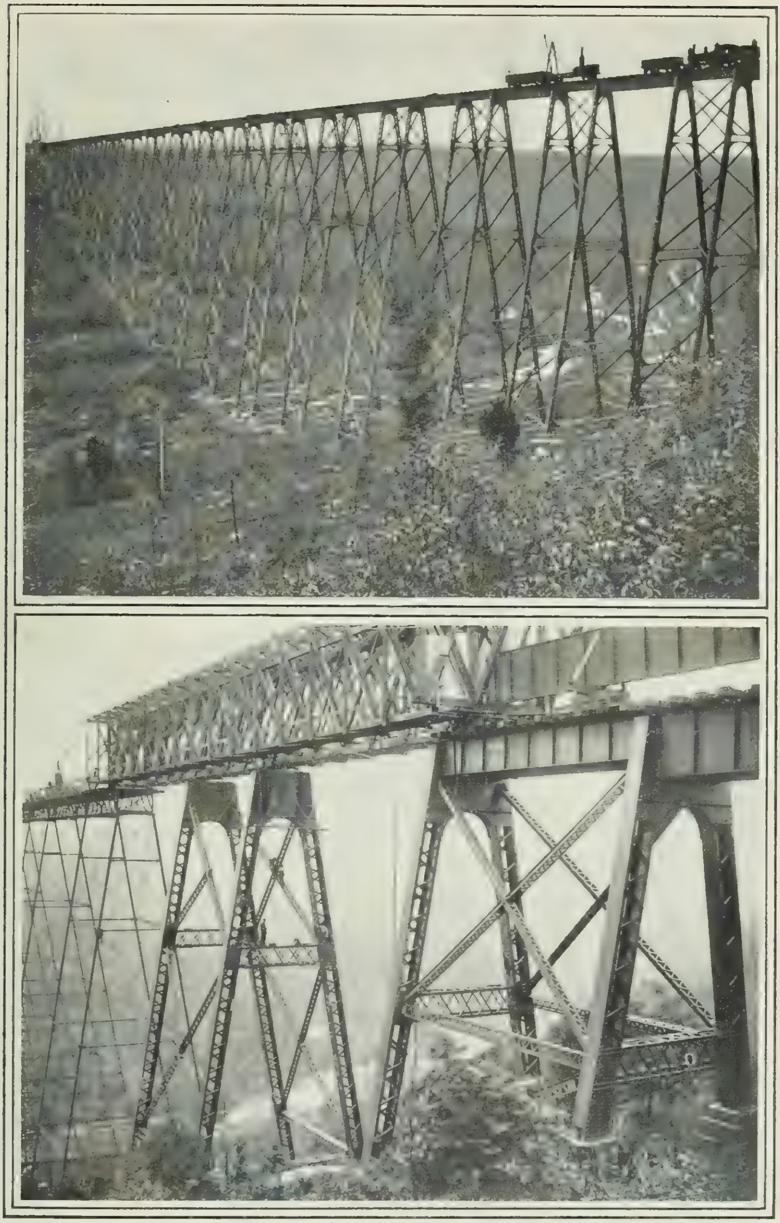
As one of the pioneers of American bridge construction, I have been asked to give the reasons why American bridge companies can offer such advantages to purchasers of steel bridges in foreign countries that they obtain orders, in spite of that prejudice which naturally favors one's own countrymen. The brief answer is that Americans are twenty years in advance of other nations (except Canada) in the art of bridge design and construction, as a short explanation will serve to show.

The steel of which a bridge is made represents about half of its cost. Steel is now made in the United States at much less cost than in any other country. In Britain, labor is so much hampered by trades-unionism that it is admitted by one of their leaders that the cost of labor in making steel in the United States is not one-half of what it is in Britain. This can be said also of the labor employed in manufacturing. Maxim tells us that after he had perfected a machine tool for making a certain part of his gun, a union leader fixed the output at one and one-half pieces daily. The mechanic did not dare to make any more. Maxim imported a machinist from Germany who turned out from six to eight pieces daily.

The market for bridges is far greater in the United States than elsewhere. The States have now 190,000 miles of railways, and it has been estimated that there is an average of one span of metallic bridge for every three miles of railway. This gives 63,000 bridges on existing lines, without including those required for new lines. The increase in the United States of the weight of cars and engines has resulted in wonderful economic changes. The average rate of freights on American railways was in 1867 a little over five dollars per ton. Now it averages ninety-five cents. Any one can figure the saving on 976 millions of tons of freight moved in 1900. These larger cars carry double the paying load of the old ones that they have superceded, and more powerful engines draw more cars in a train. This increase of weight of rolling stock has led to the renewal of the 63,000 old bridges by stronger and heavier ones. This demand has brought into existence many bridge-building companies, and they can well afford to equip themselves with the best labor-saving and accurate-working machinery, regardless of first cost, as they know it



THE BEGINNING OF ONE OF THE GREAT CANTILEVER SPANS ON THE FORTH BRIDGE—THE MASTERPIECE OF BRITISH BRIDGE-BUILDING, AND THE GREATEST STRUCTURE IN THE WORLD.



THE KINZUA VIADUCT, ON THE ERIE RAILWAY, NEW YORK STATE. ONE OF THE GREATEST VIADUCTS IN THE WORLD.

This was one of Mr. Clarke's most important works. The views are taken during the recent reconstruction, necessitated solely by the tremendous increase in weight of American engines and rolling stock. In the lower picture the relative weights of the old and new constructions are well suggested. The photographs are presented by the courtesy of C. R. Grimm, C. E., engineer of reconstruction.

would seldom if ever lie idle. European bridge builders are not in this position. Trains have not increased in weight as they have in America. The old bridges answer their purpose, and the demand has been chiefly confined to new ones. Bridge building is merely an adjunct to other business, and possibly the owners are wise in not investing much capital in special tools.

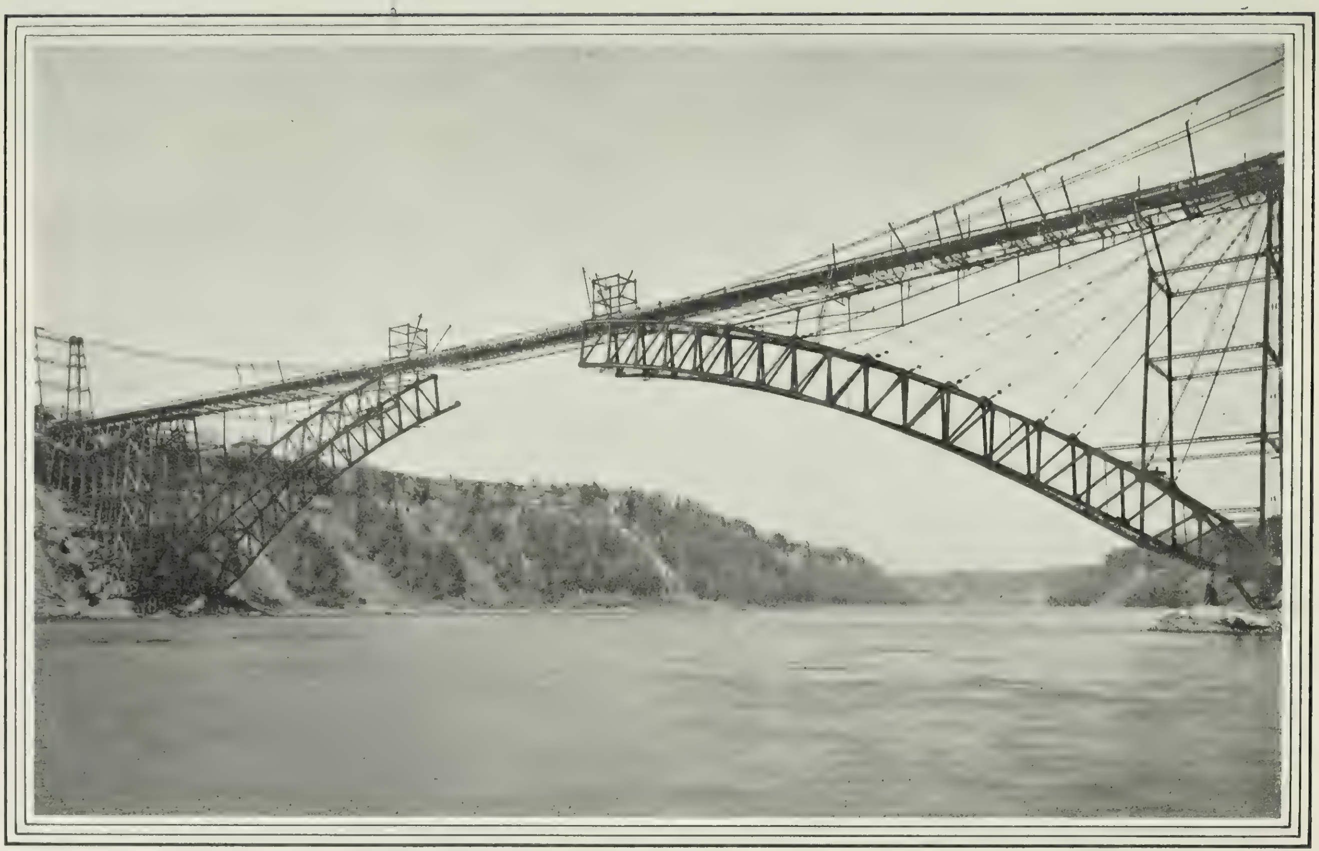
One of the most accomplished of American bridge constructors, Mr. J. V. W. Reynders, superintendent of the Penna. Steel Company at Steelton, Pa., has kindly allowed the writer to quote from a letter on this subject:

AN EXAMPLE OF CONTINENTAL WORK THE BRIDGE OVER THE INN, CONNECTING BRAUNAU IN AUSTRIA AND SIMBACH IN GERMANY.

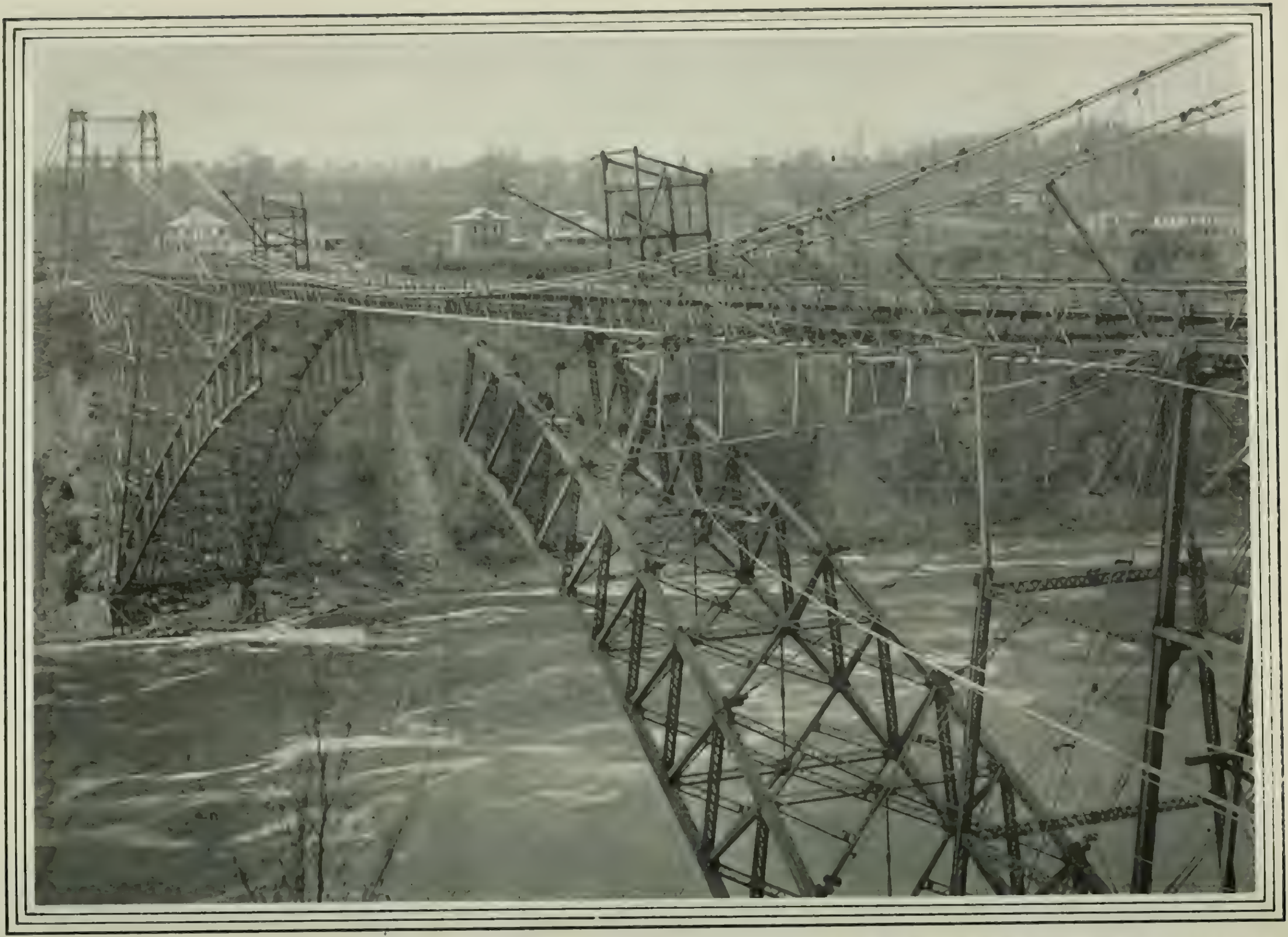
By courtesy of Gustav Lindenthal, C. E.

"Some of my impressions in regard to the causes which have resulted in the supremacy of American bridge builders, which impressions are partly the result of my visit to French, German and English shops during the summer of 1900, are as follows:

"As to general causes, our almost unlimited home field has entailed in the past a strenuous domestic competition beyond European conception. As a result, when the long-overdue trial of strength came, we were as much surprised no doubt as our competitors at our superior facilities to manufacture promptly and cheaply.



THE GREAT NIAGARA ARCH—THE LONGEST STEEL-ARCH SPAN IN THE WORLD. BUILT TO REPLACE THE SUSPENSION (HIGHWAY) BRIDGE, WHICH WAS NO LONGER ADEQUATE TO THE TRAFFIC.

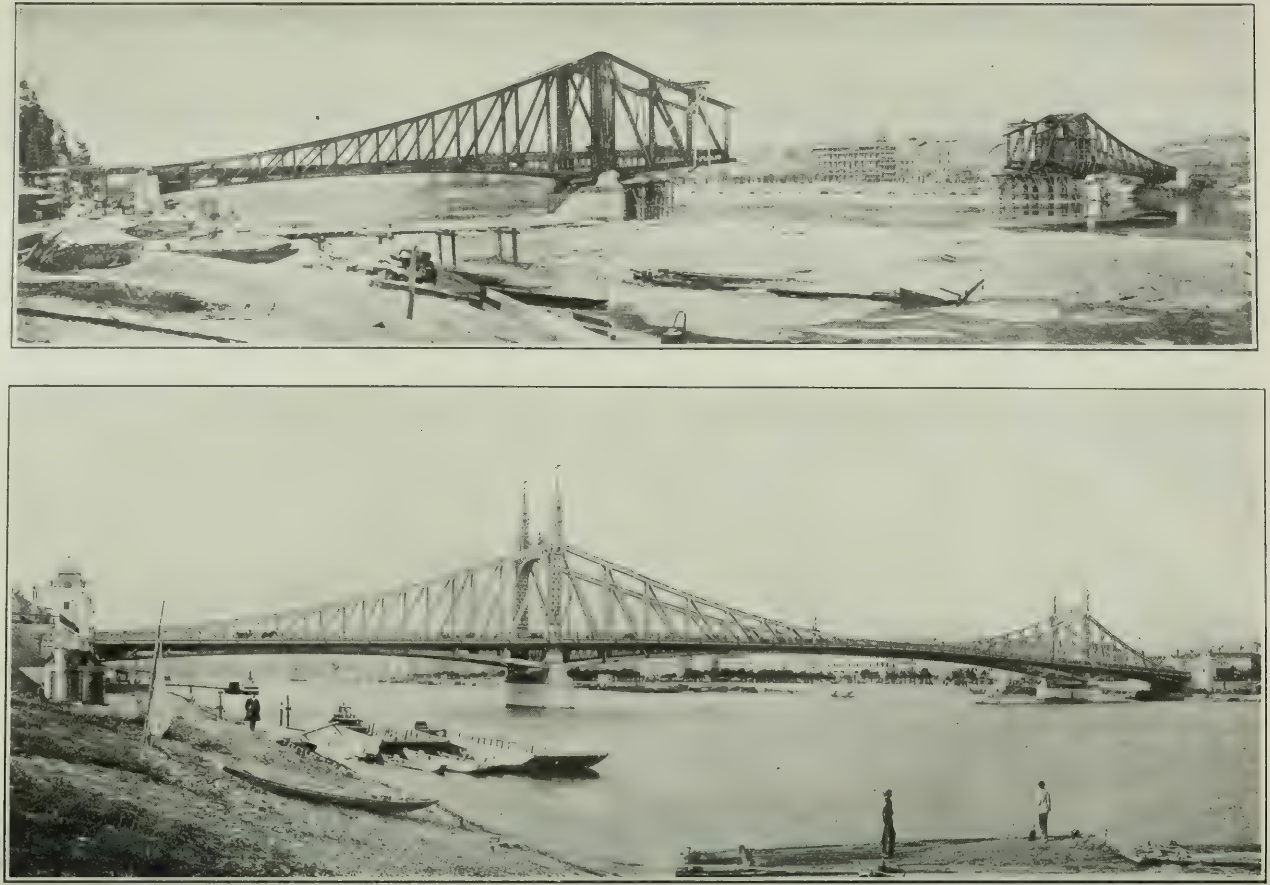


VIEW TAKEN DURING CONSTRUCTION OF THE NIAGARA ARCH, SHOWING THE METHOD OF PUSHING OUT FROM BOTH ENDS WITHOUT THE USE OF FALSEWORK.

"The development of the industry was much aided owing to the fortunate relations existing between American consulting engineers representing the purchaser and the works. Our excellent specifications were developed largely by the former, while the works management, frequently composed of young and enterprising men, kept the manufacturing facilities well abreast of the increasing demands of the specifications. A broad-minded publicity insured a practically uniform growth, not only in the development of the specifications, general designs, and details of construction, but also in the mode of manufacture and economic erection.

THE HOOGHLY RIVER BRIDGE. ENGLISH CONSTRUCTION.

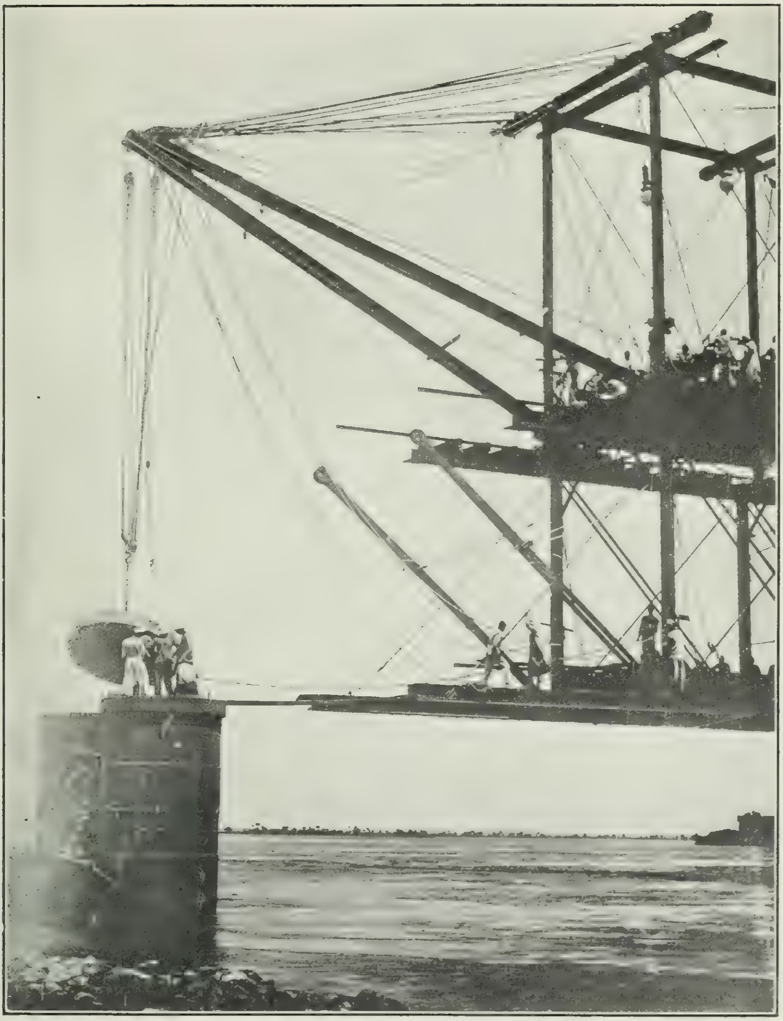
"The disinclination of European managers to invest in new appliances has become an old story, but nothing short of a personal visit to the works can disclose the amazing methods still in vogue in France, England, and, in a much lesser degree, in Germany; the manufacture and erection of bridges resolves itself largely into a 'Handling Proposition.' Much as could be said of the convenient and substantial character of our machine tools, the first problem that presses for solution is that of handling pieces, weighing many tons, from one tool to another. And this problem properly solved insures not only



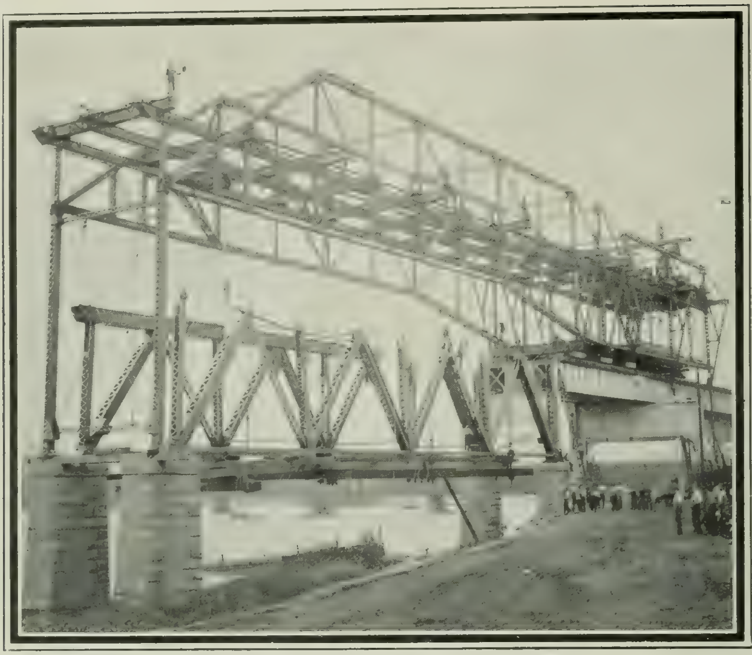
THE FRANCIS JOSEPH BRIDGE AT BUDAPEST, DURING CONSTRUCTION AND AS COMPLETED. A FINE EXAMPLE OF CONTINENTAL WORK.

By courtesy of Gustav Lindenthal, C. E.

an immense reduction in the shop labor, but brings with it an increased out-put, as against which the general and office expense remain nearly stationary. The electric traveling crane is, without doubt, the most potent individual factor in the success of American shops, next to which I would mention the application of electric motors for driving single or grouped machines, doing away with shafting or belts, which interfere with the operation of traveling cranes, and at the same time, enabling tools to be placed in such



BUILDING THE ATBARA BRIDGE. THE TRAVELER PLACING THE CAP ON A PIER.



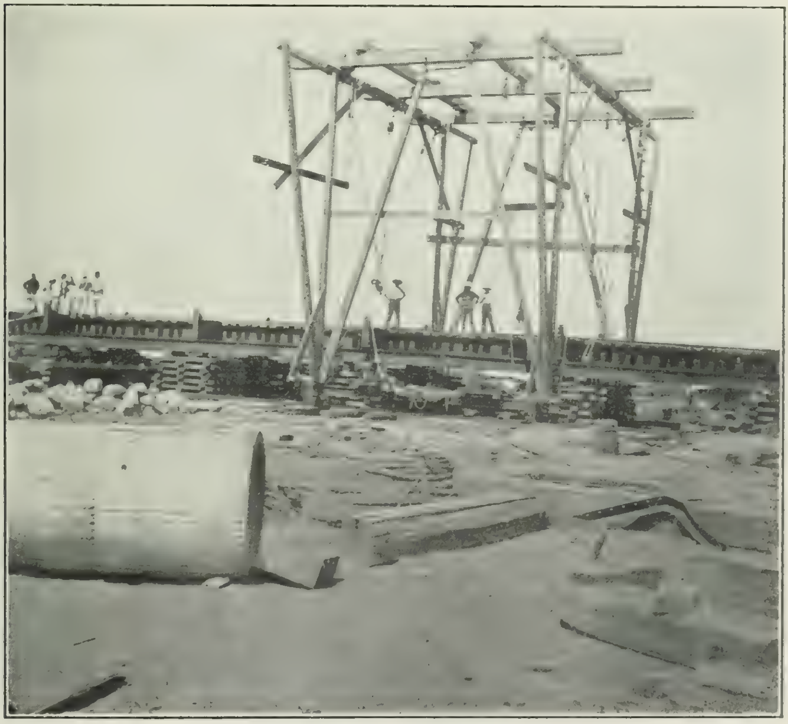
TRAVELER USED IN TERMINAL IMPROVEMENTS OF C & O. RY. AT RICHMOND, VA., U. S. A.
Total length, 213 feet 8 inches; overhang, 142 feet; base of rail to top of chord, 42 feet.
American Bridge Co.

positions that long pieces can generally be kept parallel with the direction of the general shop travel.

"In the French shops visited by the writer, handling was done entirely by main strength and awkwardness, not a single traveling crane being in evidence. Nor did a single tool impress itself on his mind that would not be consigned to the scrap pile with us. English shops are somewhat in advance of this state, and while in Germany the nearest approach to American practice is found, the scale of expenditure for equipment is much reduced. As a rule, German managers fully appreciate the state of American art of manufacture. They are restricted generally, owing to the disinclination of works owners to invest lavishly in plant, and, in point of fact, it may be doubted whether the general volume of business in Germany would enable any one modernized plant to secure enough business to keep things hustling the year round. The aggregate annual out-put of the four largest bridge works in Germany is approximately 32,000 tons, which is equivalent to the tonnage of a single American shop of the first class. In conclusion, I would call attention to one other element of our success—that is, the ability of American railroads to handle long and heavy pieces. As a result, American designers enjoy great latitude as to dimensions of single members making up a bridge, and this in turn has its effect on the design of bridge shops which are suited to handle pieces weighing in some instances as high as eighty-five tons, and other pieces such as plate girders having a length of one hundred and twenty feet or more."

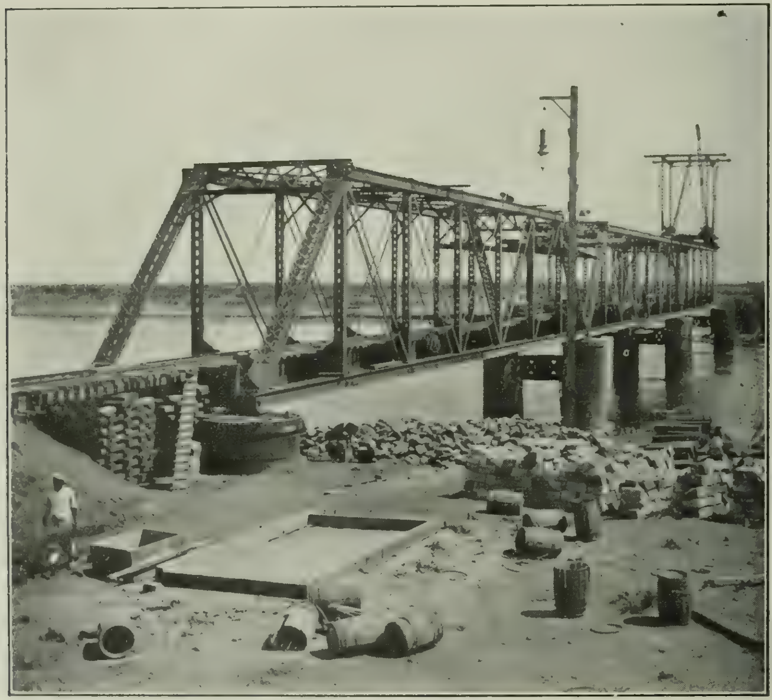
I am indebted also to Mr. Charles Macdonald, vice president of the American Bridge Co., for valuable information on this subject.

This condition of European bridge shops recalls to me the condition of those American shops which were in existence in 1870. The American bridge engineer of to-day has few of the difficulties that were overcome by the early designers of iron bridges. The mathematics of simple forms of bridges was understood in 1870, but the proportioning of details had to be worked out by each man for himself. Every new span was a new problem. Now, the propor-



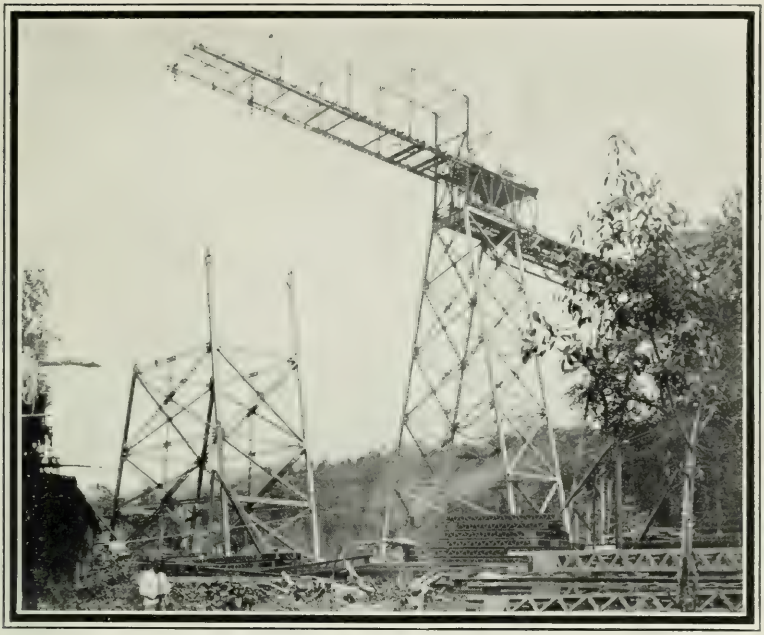
WORK ON THE ATBARA BRIDGE. THE TRAVELER.
Erected by the Pencoyd Iron Works, Pencoyd, Pa., U. S. A.

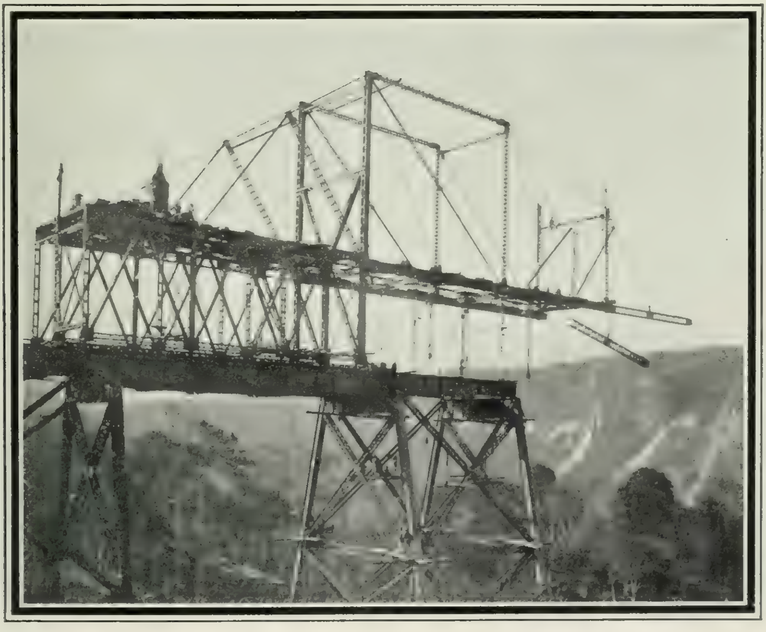
tions of lengths of span to height, and the length of panels, have been fixed by practice. Connections have become so far standardized that the duplication of parts can be caried to its fullest extent. The proper spacing of rivets is now better understood. Designs are so made that machine tools can make every part. Great accuracy is attained and the sizes of parts have increased. The bridge is never assembled until it reaches the staging or false works, and it comes together like the parts of a clock. Much of it is fastened together by power rivetters. Except in a few instances, the American bridge builders know that the designs of the engineer of the purchaser will be similar to those that he has been in the habit of working under, and no abnormal features will be embodied. Everybody now knows what everyone else is doing.



THE ATBARA BRIDGE ABOUT HALF COMPLETED.

The foreign engineer, with some notable exceptions, is somewhat isolated in his own office, and solves each problem by requiring strength and durability only, and without much attention to the use



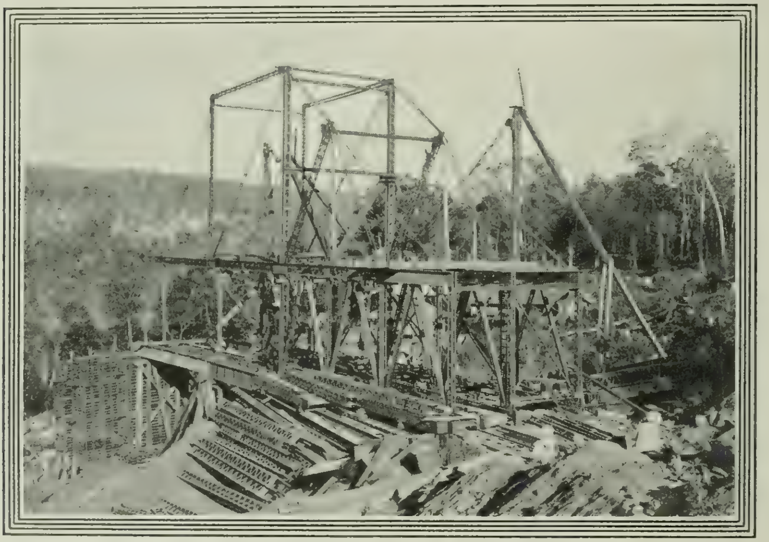


ERECTION OF THE GOKTEIK VIADUCT BY THE PENNSYLVANIA STEEL CO., OF STEELTON, U. S. A.

The cantilever traveler, in the upper view, is being employed in the erection of the next pier required by the progress of the work. Falsework is thus dispensed with. The lower view shows the traveler at closer range.

of such details as ensure economy of construction and rapidity of erection.*

It is a frequent complaint in the English press that the sections of metal called for by their engineers are unusual and not kept in stock. They complain that the details are often so complicated that duplication is impossible, and that sometimes hand labor only can be had. They complain that the economy of time in erection is not duly considered. A late notable example is of a bridge in Australia, where all the raw material was hauled seventy miles to the site, where shops were built for this bridge only. One can imagine the cost of such a bridge. In another case the engineer required that the bridge should be all rivetted together complete in the maker's yard in England, then cut apart and shipped, and rivetted a second time on the scaffold.



THE GOKTEIK VIADUCT. MATERIAL ON THE GROUND.

The results of these different methods of operation is seen in the following statement of three important contracts captured by American bridge builders from the native competitors. It should be observed that these contracts would not have been so awarded unless the engineers of the purchasers has first satisfied themselves that both the steel material and the workmanship of the Americans were quite as good as, if not better than, those proposed by home constructors.

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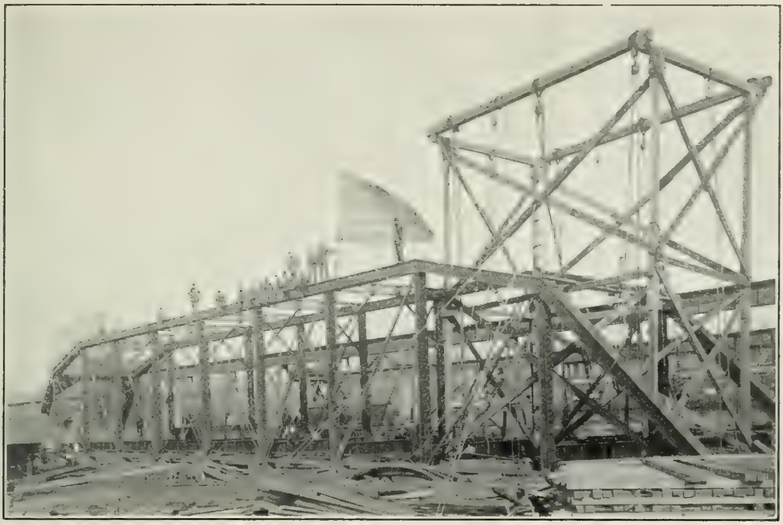
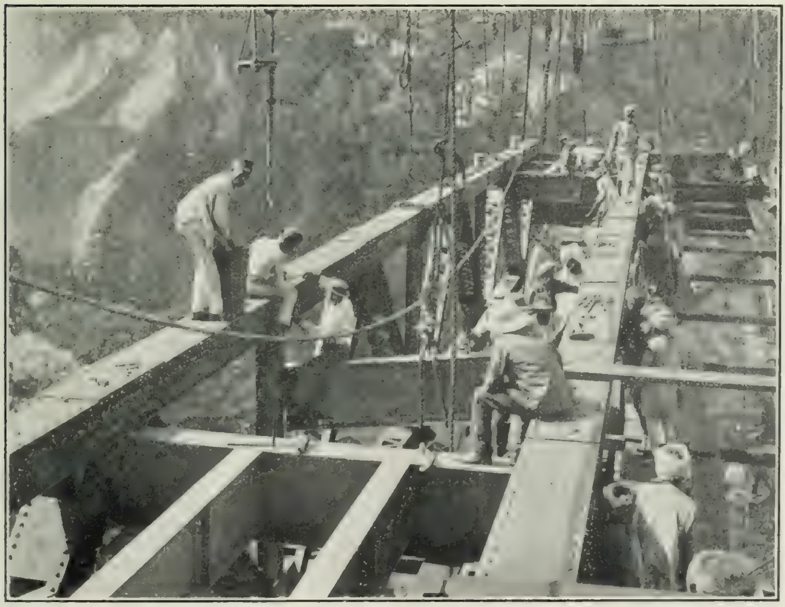
* "In this country it has been the custom since iron bridges were first constructed, for each engineer to design his own bridges, with the main object of making them somewhat different to every other engineer's design."—*London Engineering, June 9, 1899.*



AMERICAN-BUILT HIGHWAY BRIDGE FOR HOKKAIDO CHO, JAPAN.
Length 200 feet, width 20 feet, maximum height 25 feet. American Bridge Company. In this case the buyers insisted upon complete erection before shipment.



AMERICAN FOREMEN AND NATIVE RIVETTERS AT WORK ON THE GOKTEIK VIADUCT.

DESCRIPTION OF STRUCTURES.	WEIGHTS, GROSS TONS.	NAMES OF ENGINEERS.	NAMES OF CONSTRUCTORS.	AMERICAN.		ENGLISH.	
				COST PER TON	TIME.	COST PER TON	TIME.
Atbara Bridge, Africa, 7 spans of 147 feet.	622	Sir Douglas Fox.	Pencoyd Iron Works.	£10.13.6	Construction 6 weeks, erection, 8 weeks; 14 weeks.	£15.15	First span in 2 months; remainder, one span every 3 weeks.
Gokteik Viaduct, Burmah. 2,260 ft. long by 320 ft. high.	4,332	Sir Arthur Rendel.	Penna. Steel Co.	£15.	1 year.	£26.10	3 years.
Uganda Viaducts, East Africa.	7,000	Sir Arthur Rendel.	American Bridge Co.	£9.5 £18.	Delivered 10 months. Erected 46 weeks.	£15.5 £21.12.6	Delivered 60 weeks. Erected 130 weeks.

It goes without saying that proper specifications and careful and rigid inspection must insure this result. The engineer's plans were made to allow of the use of sections in stock, the details were of the American type; and rapid erection was assisted and not hindered. Everything was of the most complete modern type.

Great credit is due to those eminent engineers—Messrs. Fox and Rendel—for their liberal and advanced views, without which a fair competition could not have been secured.

The interesting question for English, French, Belgian, German, Austrian and Italian bridge constructors is—how to get back this business from their American competitors? A few large works may learn to make steel at as low cost as Americans do. To do that they must have the courage of Carnegie, who throws into the scrap heap a million of dollars of machinery that has become a little antiquated. They can observe methods of design and imitate them, as some progressive American manufactures have done. But how shall they get the constant market for bridges which has enabled American bridge companies to invest vast sums in labor-saving machinery and other appliances?

It seems to me that there is but one way, and that is to stop spending so much money yearly on armament, and apply it to the reconstruction of their railways.

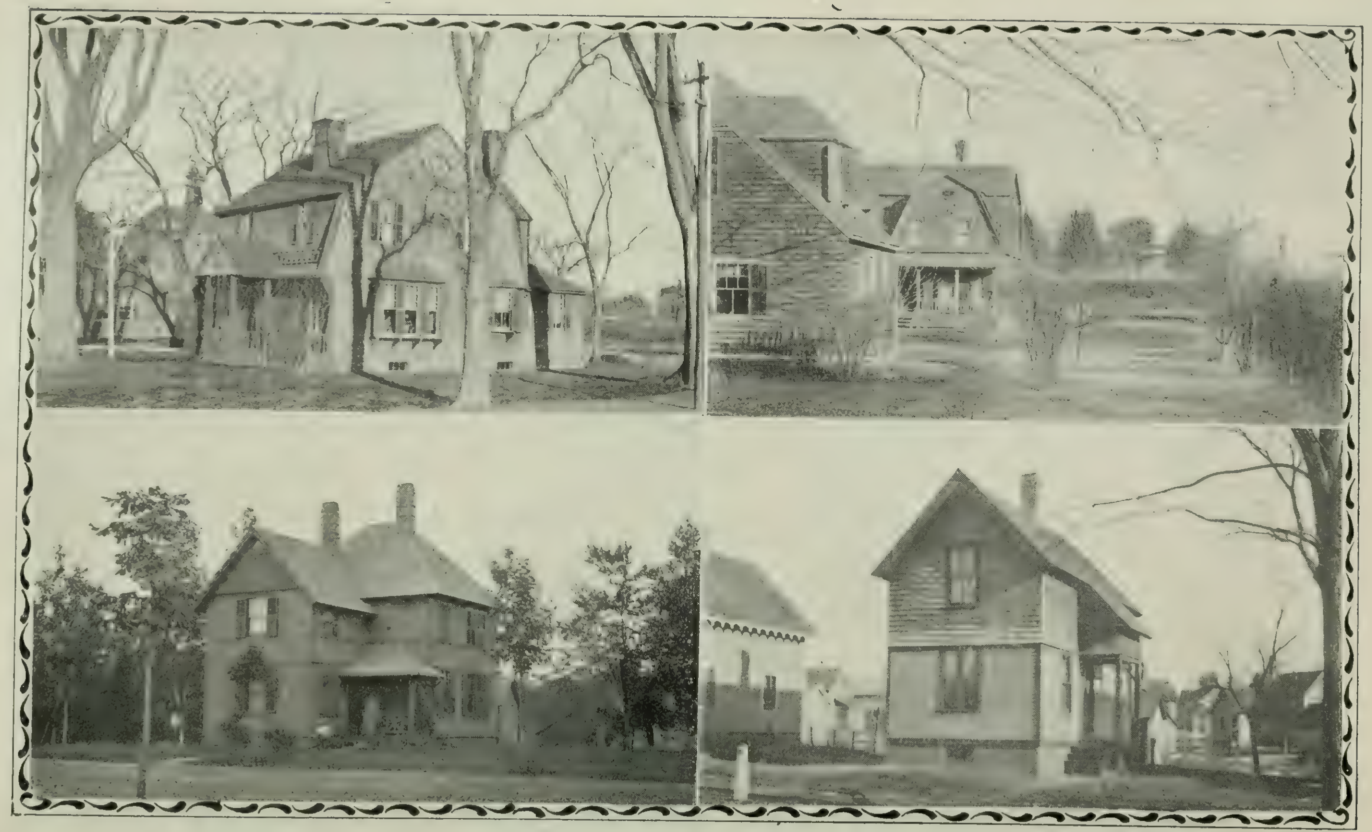
VILLAGE COMMUNITIES OF THE FACTORY, MACHINE WORKS, AND MINE.

By Charles Buxton Going.

TEN years ago this month—in April, 1891—I contributed to the first issue of THE ENGINEERING MAGAZINE a short study of "The Second Summers of Village Communities." It dealt with some of the physical problems early presenting themselves to a little town just reaching the stage where complete individualism of the people must be modified by some common action on matters of common necessity, and where the engineer is perhaps first called in to serve the community in matters of water-supply and sanitation.

But if sociological conditions have imposed engineering problems, engineering advance, on the other hand, has given rise to social questions and movements which are of the most pressing importance. The ten years just past have been characterised above all by mechanical progress and, as its corollary, by centralisation of industry. The factory system has drawn the working community toward foci, with ever-increasing intensity. Economy of production—the great all-controlling influence in the modern material world—requires the concentration of power in huge units, and about these cluster ever-growing and ever-denser swarms of machine tenders—workers of every grade. The movement goes on with almost unthinkable rapidity, but pace by pace with it move the conditions of labour, of life for the labourer, and of relations between workman and employer. Mechanical production—to use the accepted phrase—is working a revolution in economic affairs, in the distribution of industry, in the balances of trade, and in national politics and precedence. It is also working a revolution in social conditions and relations.

It is no wonder that many earnest minds shrink from the realisation of this ceaseless onrush, and wish that it might be stayed. And yet it is not mere optimism to hold that the outcome is for good, and continually for the better. Viewed in the large, the last century has done more to free the body and the mind of labour—to reduce physical toil, increase its reward, enlarge opportunities, and open the way to a



HOUSES IN LUDLOW, MASS., U. S. A.—THE INDUSTRIAL VILLAGE CONNECTED WITH THE WORKS OF THE LUDLOW MFG. CO.

The upper left hand picture shows an eight-room house; beside it is a view of the rear yards, showing their neatness. Below are a six-room cottage, on the left, and a four-room cottage—the smallest dwelling built by the company—on the right.

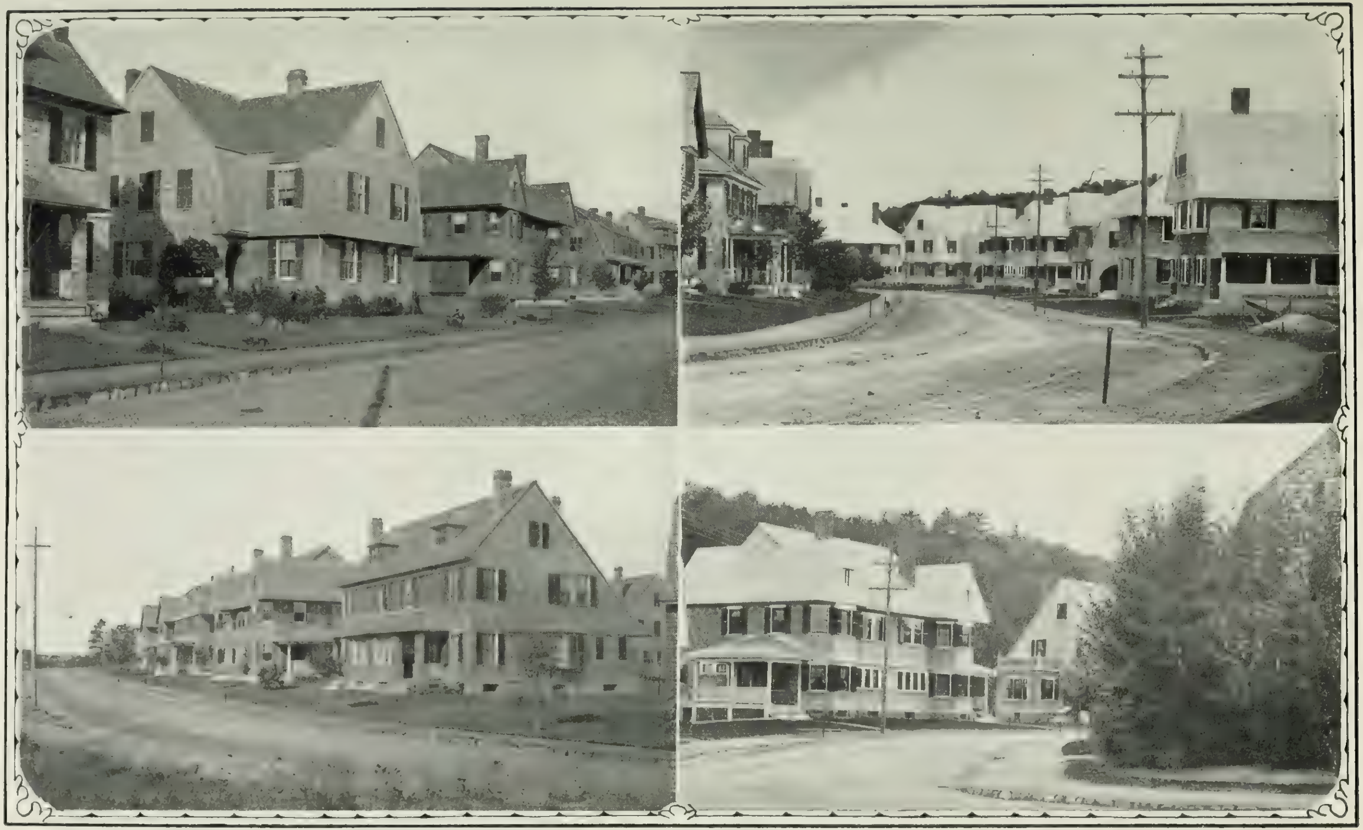
larger sharing in the higher things of life—than all the centuries which went before. The future may be most safely judged from the past. What the introduction of machinery began, the enlargement of its use will continue.

It needs time for so large an adjustment, and the period of adaptation to new conditions is a trying one. As, in the factory management, system and organisation must take the place of proprietary oversight and direction, so between employer and employee a new basis of relation must be established. The close personal contact between proprietor and workman, which belonged to the domestic and semi-domestic era of manufacturing, must give way to something else—some counterpart suited to the new order. But that it should give way and nothing take its place, would be as fatal as that management should lapse into chaos, because the owner could no longer personally direct every detail of a mammoth plant. The complex human element in a great manufacturing works needs the more intelligent provision, in even greater degree than its complex motive power and machinery need more skilful care than the little water-wheel of the first factory. But modern civilisation—at least in the enlightened industrial countries—rejects the paternalism of early days, even if modern conditions do not make it impracticable. Not the least characteristic result of the age of machinery has been the development of individuality in the worker. Enlightened self-interest demands that the employer shall consider the welfare and comfort of his men, but reason, justice, and sympathetic comprehension must be the elements of the relations—not patronage on the one side, nor unmanly dependency on the other.

It must be admitted that the perception of the employer's interest in the well-being of employee has been rather lately regained after a period of indifference to, or perhaps active rejection of, the idea that there should be—must be—such an interest. The cycle is swinging round again to a phase somewhat modified, possibly not always enough modified, from that displayed in the old days of proprietor and apprentice, when the physical and moral charge of the labourer was assumed by his master. Perhaps a prototype still closer, because on a scale more nearly equal, might be found in the great iron works of the early half of the nineteenth century. In the Black Country of England, and in the Ohio valley in the United States up to the time of the civil war, these great establishments were the largest existing aggregations of manual workers and heavy machinery. The very conditions of their being marked them out for isolation and necessary self-dependence. The mine and the furnace created the community.

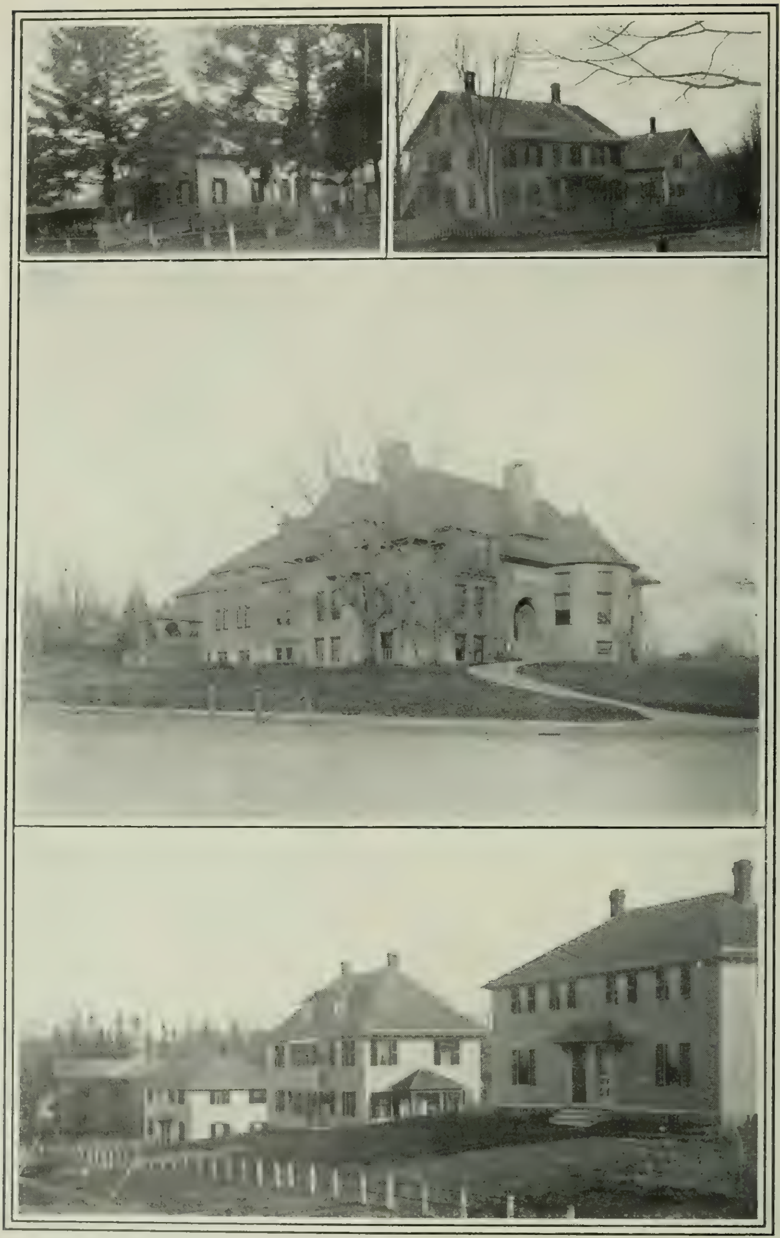
The owner of the plant was very generally, from the nature of the enterprise, owner of most of the adjoining land. He alone had sufficient facilities for securing and distributing the needful provisions and supplies. He was employer, landlord, health officer, lawmaker, magistrate, merchant. The workman, while separated from his employer by a wider gulf than now, was more dependent upon him. The system was almost patriarchal—quite feudal. The ironmaster was a petty lord and a political power of no small importance; for while internal conflict was by no means lacking, especially when the feudal baron had not the wisdom to be beneficent, the community was one in its interest in outside affairs. The often remote situation and peculiar surrounding conditions of the mine, together with the semi-military discipline which must characterise its conduct, favour the persistence of many of these conditions to the present day. With the growth in importance of factory plants, and their necessary location in outlying situations where they may have room to grow and space enough for their dependencies, there is a marked and rising tendency toward the establishment of somewhat similar relations, modernised and improved, between the factory management and factory operatives. Wisely directed, it has vast possibilities for bettering the surroundings of the working classes and creating a strong, practical, concrete political influence for sound economic legislation and the promotion of national welfare.

There is no danger of the pendulum swinging back too far. Twentieth-century social ideas are sufficient to hold the balance. The conceptions of constitutional and individual liberty are too firmly planted and broadly branched to allow paternalism to grow under their shadow. But it would be unfortunate to see efforts, well-conceived and meritorious in the main, meet a check which would reflect on other budding enterprises, simply because they did not sufficiently recognise the boundary between healthy fostering care and encouragement and an unwise even though benevolent "bossism," or an intolerable attempt to control the man because he is a workman. Probably no more carefully devised or thoroughly worked-out plans for a factory community were ever put into effect than those which took shape in the town of Pullman. Possibly the model was excellent. But individual lives cannot be stamped into uniform pattern nor made interchangeable, and the Pullman experiment, instead of preventing trouble, aggravated one of the worst strikes known in the history of America's labour wars. The way to a sound and healthy life in the factory community lies well between the two extremes of apathy and indifference of the management on the one side, and an over-interest,



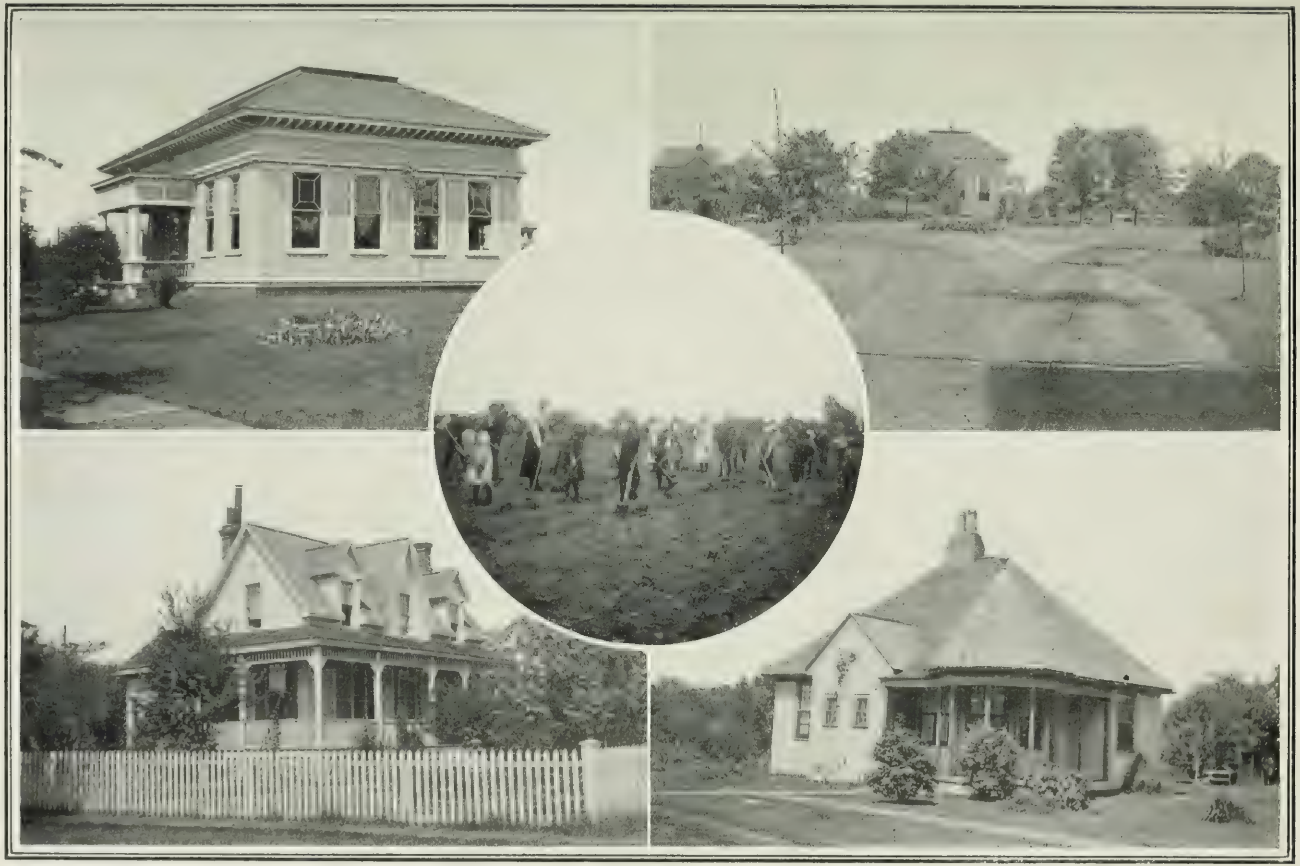
VIEWS IN THE DRAPER COMPANY'S MODEL VILLAGE OF HOPEDALE, MASS., U. S. A.

The yard of the house in the foreground of the upper left-hand cut received the first prize in 1900. The other views give an excellent idea of the class of dwellings and the neat and attractive streets.



FEATURES OF THE PEACE DALE MANUFACTURING SETTLEMENT.

The central view is the Hazard Memorial Hall, built by the owners of the company for the use of the village and containing library, gymnasium, baths, class-rooms, and hall. The other pictures are of operatives' cottages. The school-house is in the background of the lowest picture.



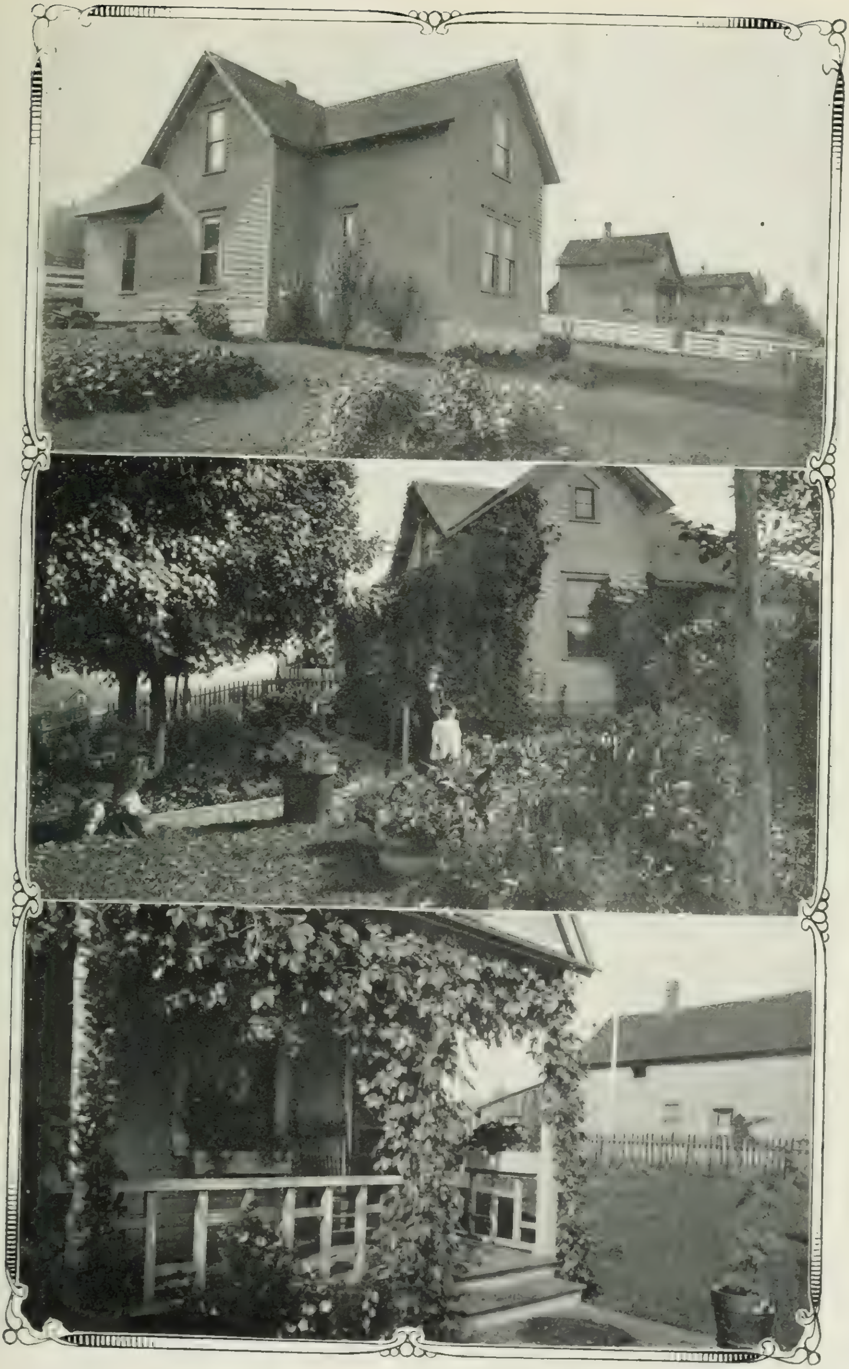
THE CO-OPERATIVE VILLAGE OF LECLAIRE, FOSTERED BY THE N. O. NELSON MFG. CO., ST. LOUIS, MO., U. S. A.

On the upper line are the public hall (on the left) and school house (on the right); below are typical workmen's cottages. **In the center is the children's gardening club** at work.

coupled with chafing restrictions, on the other. But that the happy mean can be found, and when found will promote mutual satisfaction and prosperity, is amply shown by a rapidly increasing number of examples in the manufacturing world.

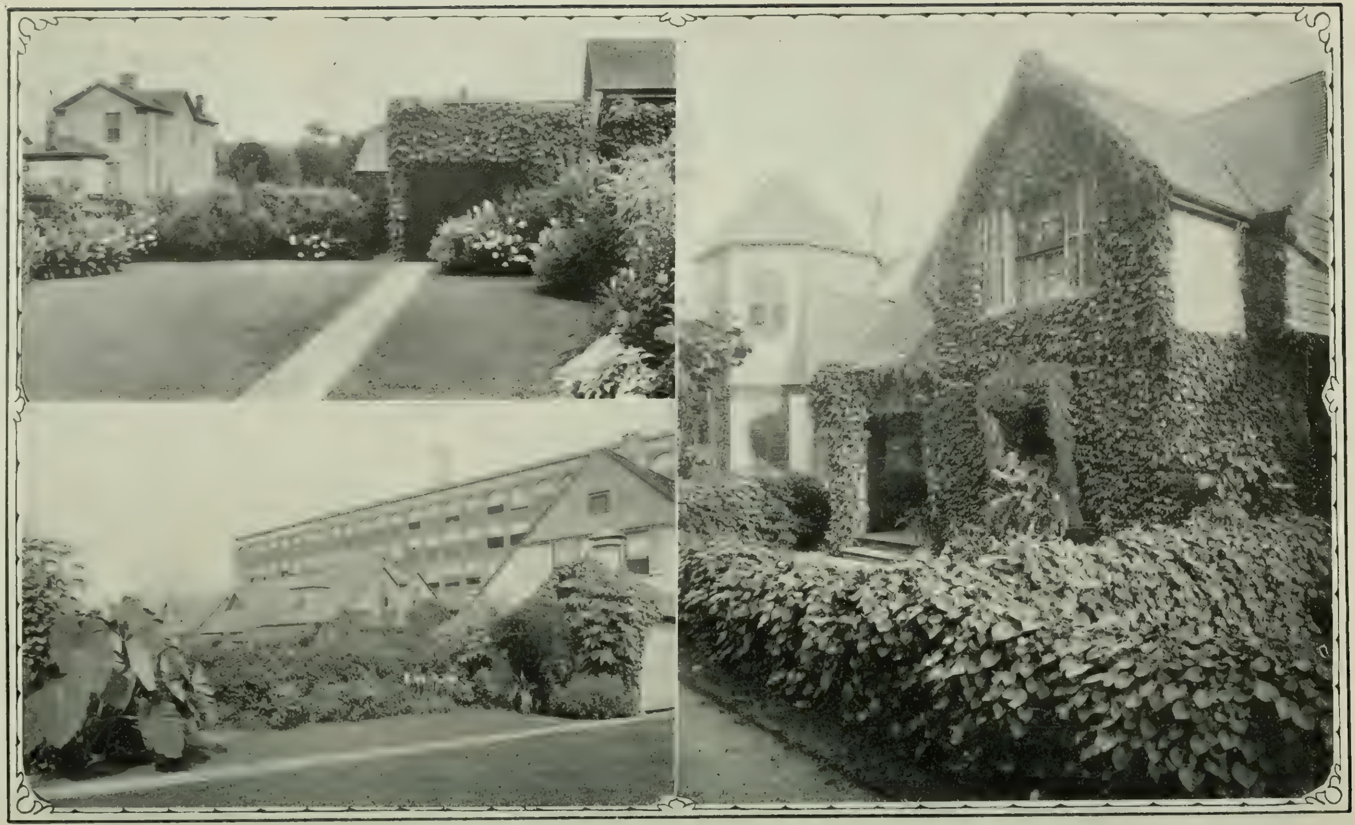
The most obvious step in protecting a factory community through the critical times which come with increased pressure of intensity on its life, is one whose simplicity puts it within range of every establishment, large or small. It is confined in its exercise within the factory, and is simple attention to those matters of hygiene and comfort which the workman can not provide for himself, but which are essential to physical well-being (and hence to high efficiency) and to the promotion of good personal habits and self respect. Such matters are proper ventilation and heating—discussed elsewhere in this number by Mr. Allen—proper facilities for washing, provision for changing clothes, and decent sanitary arrangements. Coupled with these is the provision for bath-time during working hours without loss of wages —a tacit recognition that conditions of employment which bring dirt and discomfort should provide also for its removal. Next come provisions for providing meals, or supplementing those which the workmen bring with the nourishing or appetising things which can not be carried, or which the situation of the works or the shortness of the meal-time make it difficult and unduly expensive to procure. Something can be done in this way, also, toward directing the employees' attention to more nutritious and wholesome dishes than they have been accustomed to provide for themselves. Beyond this again are the opportunities for mental improvement through the establishment of club-rooms, assembly rooms, lectures, libraries, and other means of education in the subjects most helpful in the men's work. All of these are well-recognised and largely practised, and readers of Mr. Patterson's article in the Works Management Number of THE ENGINEERING MAGAZINE, in January last, will recall the many successful instances he cited and the forceful unanimity with which Messrs. Patterson, Orcutt, Bell, Canniff and others urged the practical value of thus increasing the employee's helpfulness and efficiency and establishing a community feeling in the works by a manly regard for the workman's intelligence and proper surroundings.

But it is outside of the factory walls that the workman spends most of his life, and here the interest of the employer more rarely follows. This is an oversight all the more grave because, with the growth in size of individual plants and the increase in the number of works employing thousands of employees, the distinctly "factory com-



MINERS' HOMES, CLEVELAND CLIFFS IRON CO., ISHPEMING, MICH., U. S. A.

The lower and middle views are of first-prize cottages for the season of 1900; the top shows a house which took second prize for the best-kept premises the same year.



EFFECTS OF THE ENCOURAGEMENT OF EMPLOYEES' INTEREST IN THEIR HOMES, NATIONAL CASH REGISTER CO., DAYTON, O., U S. A.

The cut on the right shows the results of vine-planting; on the left, below, is a view of the back yards of employees' houses. Above that is a single yard, which took the Ladies' Home Journal prize in 1900 for the "prettiest back yard in America."

munity" is becoming a larger and larger element in economic and political influence. If, by patient exercise of a due and consistent regard for the workman's welfare, the employer establishes a feeling of mutual regard and sympathy, much of the misunderstanding between capital and labour will be effaced and no demagogue will dare —or should he dare, will succeed—in playing upon the suspicions of one side to enable him to fleece or force the other. United, they will be an irresistible power for wise and stable economic legislation.

It is therefore, to repeat, by a grave oversight that the manufacturer has not oftener considered the employee's interest parallel with his own in building up his works. Within city limits, this is perhaps hardly possible; but there general conditions govern the cost of living and the employer can scarcely, without meddling, enter into his employees' arrangements in that regard. But it is growing more and more common for large works to move, or to be established, in rural and semi-rural districts, where land and taxes are low and there is room to spread as the growth of business may demand. Under these conditions it has been altogether too common—at least in the United States—for the proprietor to make the best arrangements he could for himself and leave his workpeople to get what they could after his bargain was tightly closed. It is not at all uncommon for a factory site to be given to the owners of the business, free of any charge and often free of taxes for a period of years, in consideration of their locating in a certain place. The neighbourhood gains from the increased population and the increased chance of employment for its own people; but the employees practically pay the bill for the site, for all ground nearby is advanced greatly in value, houses are built in certainty that they will be absolutely needed by the incoming army of workers, and local landlords and lodging-house keepers put up their prices to the limit. I have known personally of men who made their living by dealing in factory sites—buying up or securing options on available properties, getting some large manufacturing plant, under good inducements, to take enough for their own purposes, and making his handsome profit out of the adjoining ground—the higher values being paid, immediately or indirectly, by the workingmen and their families.

In a case of this sort, where the men's interest is diffused and almost intangible—at least, incapable of being concentrated into a unit which can operate with the factory management to joint advantage—it certainly seems as if it would be only reasonable and just for the employers to act as trustee of the tacitly confided interest of their men, and to secure for them the same advantages they get for themselves. In this there would be no paternalism, but simply the regard which an active partner might show for an unrepresented one—simply the regard which, it is now recognised, a controlling stock interest should show the other shareholders. And here the question is not one of abstract principle but of practical relations, for the management and the employees must continue to work together, and everything that makes life fuller and more satisfying to the workman tends directly to the advantage of his work and of his employer.

The after adjustment might be determined as good judgment and the special conditions direct. The main point is that the development of the very desirable factory-community spirit can not well be fostered by starting with a real-estate deal in which capital takes a virtual profit at the expense of its co-operative element—labour. As Mr. Shuey says:* "The experience of Pullman and similar efforts has not encouraged others to do much toward building towns owned and controlled by the company," though throughout the new cotton-manufacturing district in the southern States this is at present the custom, as it is in some leading English examples—notably, I believe, the Cadbury Brothers' village at Bourneville and the Lever Brothers' settlement at Port Sunlight. In New England are to be found some of the best-established examples in the United States—those whose soundness of basis is evidenced by the length of their existence and their satisfactory results to both sides. One of the most clean-cut and definite instances, perhaps, is the village of Ludlow, Mass. The company built the water works, gas works, electric-light plant, churches, and school houses. Their general policy with regard to the employees' residences can best be given in the words of Mr. J. E. Stevens, agent of the company:

> "Our efforts have been to give every family a complete home, even if it has but four rooms, which is the smallest cottage we build. We avoid as far as possible building anything in the way of blocks, and what is known as the usual mill-tenement block we have long since discarded. When we first began building the modern type of cottage, or about twelve years ago, it was our policy to sell to any of our operatives who cared to buy, and as a matter of fact we did sell several cottages with lots of about one-quarter acre. We sold the cottages for about the cost of building, calling the land nothing, and making easy terms of payment. This plan, however, did not work out successfully for the reason that rules drawn up to promote the health and comfort of the community at large could not be enforced against individual holders. For this and kindred reasons we have ceased to sell cottages and, in fact, bought back at a premium those we sold. Our rents are made as low as can consistently be done, and are much lower than the prevailing rents in this neighborhood. It is our intention

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* Factory People and their Employers. E. L. Shuey. Lentilhon Company, New York.

to offer prizes for the best-kept homes and gardens, for while many tenants take an interest in their surroundings, others are wholly indifferent and can with difficulty be got to co-operate in the protection of shade trees. In designing our cottage homes, we have limited our study almost wholly to the inside; many of these we believe are models of comfort and convenience. We have not made an effort to obtain striking or even showy outside effects, but have rather adopted plain exteriors, with a view to minimum of expense for repairs and maintenance."

Another strikingly successful factory community in the State of Massachusetts is Hopedale—a small place of about 2,000 inhabitants, whose only industry is operated by The Draper Company. It is, in fact, a typical example of the factory village. The tract of ground on which it stands was laid out at the company's instance by a prominent landscape architect, and sidewalks, sewers, and other improvements were put in. The principles governing the relations of the company to the community of its employees are thus defined by the assistant agent, Mr. F. I. Dutcher:

"We do not give special encouragement to our workmen to buy their own places. Hopedale is a very small town and our company operates its only industry. It is necessary for us to furnish tenements to a great many of our people, and, on the other hand, those employed by us owning their own places, in case they should leave our employment, are not as well situated as they would be in or near a large town or city if left with a piece of real estate on their hands. We do make an inducement in the way of rentals, in the fact that our rates are based upon an extremely low percentage of income, so low, in fact, that no outside parties build tenements for this purpose.

"To encourage care of the premises about the houses of our employees, we offer every year premiums covering the general outside conditions both of the front and back yards, and shall distribute for the coming season $300 in this way. We have found after an experience of quite a number of years in this direction, that the average condition of the premises has greatly improved.

"Two boarding houses are owned by our company, and are operated independently by people who rent them, but we do reserve the right to limit the price to be charged for board and to keep a certain amount of supervision on the way in which things are run.

"The local government in Hopedale is the same as in any Massachusetts township. While our people interested in and owning the works of this company are in a way equally interested in the town, its boards and officers are elected by people having a right to vote, and without the least regard to property ownership

"As far as the writer is aware, there is a good understanding between the employers and employees in this community. We have had absolutely no labour difficulties for many years, and none whatever that were at all serious."

The Peace Dale Manufacturing Company, of Peace Dale, Rhode Island, is yet another New England example of the distinctive factory community, and one in which personal, family, business, and village interests have been linked together for nearly a century. The company built the town hall, library, and village church. The Hazard Memorial, shown in the center of the grouped views on page 64, contains, library, gymnasium, baths, class rooms and hall, and was built by the owners of the company for the use of the village. In this case. the treasurer of the company writes, the employers build houses for rent to the help, and also encourage them to build and own their own houses by loaning money and selling land on easy terms. In some cases operatives have not only acquired their own houses, but have secured additional houses and themselves become landlords.

One of the most characteristic of American industrial settlements is the co-operative village of Leclaire, connected with the factories of the N. O. Nelson Company, near St. Louis, Mo. It would be impossible to set forth its constitution or its effects more forcibly than in Mr. Nelson's words. In a brief magazine article published a few months ago in "Our Day," he said:

> "It is a wretched arrangement by which men are huddled together in ugly factories. We have tried to make the factories attractive as well as healthy. Our days are shortened by the fact that the homes and factories are close together; no time is lost in going and coming. Every home has about a third of an acre of ground attached, thus holding one foot on the sod and one in the factory.
>
> "Leclaire was an outgrowth of the profit-sharing system, which was adopted in 1886, and still continues. In the first ten years the dividends on wages amounted to 57 per cent. In the last four years there have been no dividends, the earnings being invested in additions and improvements. But much more important than cash dividends is the improved living, the co-operative spirit, unconsciously absorbed from the common benefits enjoyed out of the fund jointly created."

In answer to my special inquiry, Mr. Nelson writes the following fuller explanation of the policy and constitution of Leclaire:

> "Leclaire is built upon a farm of 125 acres, platted into streets, blocks and lots. The land is owned by me as Trustee for the Nelson Mfg. Co. The lots when sold, are deeded in fee simple.
>
> "There are no legal co-operative elements. Co-operation is entirely voluntary, as well in the social things as in the public things that are provided and maintained by the company. In that respect, the corporation acts as the agent for that associated number of men who do the work and who, with their families, want these public things.
>
> "There are only two legal bodies: the business corporation, and the 'school and library association,' which holds the endowment fund and manages the school library and looks after the village public affairs. The settlement is not at all restricted to employees. At first, we built the houses for the employees on plans agreed on with them, and they paid for them in monthly installments.

Now, they build with their own money and loans from the outside, either from building associations in Edwardsville or private lenders. The company owns a few of the houses, but it has no intention of being a landlord. These few are mainly those that have been taken back from employees who left, and they are a convenience for newcomers until they get naturalized and conclude whether they are permanent residents or not.

"There are no ordinances or regulations for the village or its residents—none whatever. There is no local incorporation or authority except the county and township, and especially is there no boss. I live in the village myself, but no resident has ever been asked by me to do anything or refrain from doing anything. Every resident understands that he is as free as he would be on a farm.

"Very decidedly, Leclaire as an institution promotes sympathy and understanding between the work people and employers, and diminishes labor troubles to the vanishing point."

A somewhat less unusual policy is pursued by the Cleveland Cliffs Iron Company, of Ishpeming, Mich., but a policy which nevertheless is addressed directly toward establishing a bond of sympathy to bind the community together by other ties than those of mere payment and receipt of wages. Its most characteristic feature is the stimulus to thrift and neatness, by means of prizes given annually for well-kept premises and prettily planted gardens. Some of the results are shown on page 67. The more general relations of the company with employees are thus explained by the agent, Mr. M. M. Duncan:

"The company owns some sixty houses, which it rents to its employees at a very nominal figure; in fact, about one-half of the rates prevailing on properties owned by individuals in the city. These houses were built many years ago to attract labour to this district. Up to this time we have leased ground to those wishing to build, the rent for which is from $12.00 to $15.00 a year, in some cases exempt from taxation and in some cases the lessee pays a nominal tax.

"Of the mine employees of this city, there are about 1,125 employed by our company, about 725 by the Lake Superior Iron Company, and about 500 by the Pittsburgh & Lake Angeline Iron Company. These all live within the city limits, and all take interest in municipal government. The company retains some influence in local government, but not to the extent of holding municipal offices. The municipal officials are made up from employees of some of the mining companies and business men, as is also the city council and the county board of supervisors."

The policy of fostering the employee's interest in his home and establishing a communal interest by co-operative and competitive effort in this direction, is pursued also by the National Cash Register Company, of Dayton, Ohio, in connection with other altruistic efforts fully described by Mr. Patterson in THE ENGINEERING MAGAZINE last January. Their methods are thus defined:

"We simply stimulate and encourage our employees to beautify their homes. The company does not own or rent a single dwelling house, and does not believe in attempting to do so.

"Our work was started by organizing the South Park Improvement Association, composed of residents of South Park interested in beautifying their homes, and while it is entirely independent of the factory, we encourage them in every way possible by loaning them stereopticon slides, letting them have the use of our hall, and all facilities. In our Sunday school, which might be termed a Sunday club, we teach the principles of landscape gardening, distribute free seeds, and offer $250 annually for the best results in home beautifying."

Referring to the illustrations of the results, which are shown on page 68, Mr. Shanklin says:

"One point which we desire to call particular attention to is that these results are all obtained with the cheapest of shrubs, vines, etc., and all of them quick-growing plants indigenous to this climate.

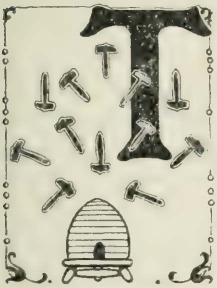
"These simply show the employees' efforts, and we have not attempted to show photographs of our own landscape gardening about the factory for the reason that it might be said that the company can afford to do these things but private individuals cannot. We want to show that this is not true."

It is not coincidence that the concerns which take these views regarding the relations between employer and employee are conspicuously fortunate in their freedom from labour troubles. The list of such concerns is lengthening at a wonderful rate, but the millennium is still far off. There are yet workmen who are "wholly indifferent and can with difficulty be got to co-operate." There are yet employers who look with disgust on what they call "coddling" the men. There are yet mine stores exacting so large profits on their compulsory sales that they more than support an unprofitable mine. Where these conditions persist, the factory community will hardly survive its "second summer." But such instances serve as foils to set off the better way found in the better-directed plants which are working toward fuller understanding and fuller co-operation between labour and capital. That this basis of mutual support should exist grows every year more vitally important. A larger and larger proportion of the nation is annually engaged in manufactures. With the increase in size of individual plants, waxes rapidly the possible damage, to the concern and the community, from the clashing of opposing parties. But organisation, which was conceived, even by its promoters, to be an institution of war, is rapidly revealing itself as the most effective agency for stability and peace. When to the reciprocal understanding and tolerance which it is bringing about between capital and labour in the large, is added the community feeling, the sense of unified interest, and the *esprit de corps* induced by an enlightened policy in the individual works, the "second summer" of the working community will be safely passed, and the way be open to stable industrial peace and the enduring welfare of both employers and employed.

THE ECONOMY OF HEATING AND VENTILATING THE MACHINE SHOP.

By Leicester Allen.

The initial number of THE ENGINEERING MAGAZINE, ten years ago this month, contained an article by Mr. Allen on "Heating and Ventilating Homes." A decade of wonderful progress in the economy of mechanical production has brought about, as one of its most striking results, a lively appreciation of the fact that the highest utility and efficiency can be secured only by surrounding the factory or shop worker with the best physical conditions—that the man, even more than the machine, must be put into a favourable environment. The following article is addressed to this highly practical idea so far as it relates to the machine-shop.—THE EDITORS.



THE word "factory," in the United States, is so loosely used to include all places wherein any specialized manufacture is carried on systematically that it will be proper in such a discussion as is herein contemplated to prescribe more definite limits to the use of the term. Boards of health have frequently been called upon to condemn the unsanitary conditions of sweat-shops, among whose sanitary sins the want of any approach to proper ventilation is, perhaps, the most pronounced evil. On the other hand there are multitudes of industries conducted in large establishments employing from one hundred up to two thousand persons, or more, in attending machines and in manual operations, in which no special provisions for ventilation exist—where they have not even been thought of as useful or profitable. So far as I have had opportunity to scan public health reports this condition of factory industry is very meagerly—indeed very gingerly—dealt with, even when, rarely, it is noticed at all.

I propose in this article to urge the propriety and desirability of giving more attention to heating and ventilation in large manufacturing plants, and to discuss very briefly general features of the problems that will arise should this desirability be widely recognized. As the question of heating is always influenced, at least quantitatively, by the amount of ventilation planned, and as ventilation is, when not mechanically effected, usually attempted and sometimes well-accomplished by currents of air set up by heating, the correlated topics of heating and ventilation of any class of buildings can not well be separated in a discussion of this kind.

As to the desirability of good ventilation in large factories, I might urge altruistic motives; but more and more the control of such establishments is falling into the hands of large incorporated companies, popularly called trusts, and I fear that altruism can hardly be put down as one of the moral assets of such capitalistic combinations. A more hopeful argument seems to be the very opposite motive, self-interest. It requires but little thought to reach the conclusion that, in a building containing a thousand human working units, a very small per cent of increase of individual efficiency would amply pay for a considerable aggregate expenditure. To get the best return for wage expenditure is the problem which every good manager of a factory has to solve. But the best can be obtained only under essentially favorable conditions. For example, I once was engaged in a crowded drawing office in executing some fine diagrams representing graphically the behavior of gases, under various pressures and temperatures to which they would be subjected during a cycle process. No special provision existed for the ventilation of this room, which was heated by pipe coils placed under windows. Those obliged to work near the windows could not tolerate having them opened on account of vicious drafts which swept in from the surface of an adjacent ice-covered river. In that room I was frequently attacked by blurred vision. A single line appeared as two, vibrating or undulating throughout their entire extent each into the other, making futile any attempts at accuracy until, by a walk in the open air of twenty minutes to half-an-hour, the disturbance of vision was removed. No doubt the work in that ill-ventilated den cost 10 per cent more than it would have done in a comfortable well-ventilated office. The wages paid there must have been at least $50 to the entire force each day, and if by reason of decreased efficiency one-tenth of the possible service was not rendered, the employers lost $5 a day during the cold season, which might have been saved if attention had been given to proper heating and ventilation.

What is true of a drawing office is equally true of an apartment filled with persons employed in more purely manual work. A listless, inattentive operative is worth much less than an alert, interested worker; and, so far as I am able to judge, nothing so breeds listlessness, inattention, and carelessness in a shop or factory as a vile atmosphere coupled with defective heating. By defective heating is meant a temperature either too low or too high for the perfect comfort of the workman in the execution of his special work. It often happens in factory industries that in the same room some are employed in work that requires much physical exercise while others are occupied in watching or attending machines requiring vigilance rather than muscular exertion. At a temperature that is comfortable to the men actively exercising, mere machine attendants may be uncomfortably cool, and when the latter are warm enough the former may complain that they are overheated. This remark leads up to a principle in the assignment of work to different rooms of a factory, which, if systematic ventilation is recognized as desirable in factory management, will be one of the features of the problems presented.

It will be necessary to consider the temperature most favorable to progress in the various operations in special industries, and to classify the operations in this regard in different rooms in such a manner as not to interfere with other economies—such as a minimum of time and labor in passing incomplete work along for other operations and for assembling and packing. In some industries, as in cotton mills, woolen mills, and knitting mills, where the manual labour is light and consists almost wholly in attendance upon automatic machines, this classification and arrangement are already sufficiently perfect to admit of good uniform heating with equally good ventilation; but, while the temperatures of weaving and spinning rooms are carefully attended to,—for the reason that the perfect operation of the machine is more-or-less dependent upon a temperature sufficiently high to make the material work well,—ventilation is very little cared for. The smell of oil and the peculiar odor of wool disguises the "school-house smell" —as writers have been pleased to style the odor of ill-ventilated schoolrooms,—but it is there, all the same, and its causes are the same—exhalations from the persons of the operatives.

I recently examined on the boards of an architect some plans for a costly stable to be erected for the owner of valuable horses. A considerable item of expense called for in these plans was a system of ventilation for the stalls. I asked the architect whether this was demanded by the owner, or whether it was put in on his own initiative. "Why bless your heart!" was the reply, "the owner of those horses has brains. He knows that the health of horses must be perfect to have them show their best and do their best, just as much as though they were human, and a horse can not be kept in perfect health in foul air any more than a man can. 'A well-ventilated stable' were almost his first words in requesting me to draw the plans."

Surely this is a lesson on the value of ventilation to employers who want to get the best results for their wage expenditure. The total lack of pertinent statistics makes it impossible for me to enforce this lesson with an array of figures such as would prove the proposition.

It appears very strange to me that the subject of factory ventilation has received so little attention, while the collateral subject of factory heating has been carefully studied. Most of the ventilating appliances, where the nature of the operations carried out are such as to compel some sort of ventilation, are miserably inadequate, and it is only in recent years that forced mechanical ventilation has been adopted even in manufactures where deleterious or even poisonous gases or dust are evolved from the materials operated upon.

The overhead system of heating by steam-pipes ranged and suspended near the ceiling, where revolving shafts, pulleys and belting keep the air in motion, is a convenient way of heating a workroom and relieving the floor space from heating apparatus; but such ranges of heating pipes accumulate dust, and their position is unfavorable to a good system of ventilation. The extent to which overhead heating has been adopted in itself indicates the small importance in which factory ventilation has been held hitherto. Now, when it is remembered that rooms in most factories usually occupy entire floors—say 50 feet wide and from 100 to 300 feet long, while their height is not more than from 16 to 20 feet—it will be seen that a very different set of conditions exist in factory ventilation from those presented in a church, school, or theater. To attempt the removal of impure air from an outlet at one or both ends, or from the ends and the middle, of the room would entail the suction of all the bad air toward these points of egress, so that while in some parts the air might be unobjectionable, in the parts near the outlets impure air would be massed. The only correct way of ventilating such a room, in my opinion, is by numerous outlets uniformly arranged around the walls, and equally numerous inlets for pure air, and the securing of constant and uniform circulation by mechanical means. In designing a new building this would add very little, if anything, to the cost of erection. With engines of the non-condensing type supplying motive power, the exhaust steam can be used for heating and generally this supply would be ample. The current cost for ventilation would, in such a case, become the interest and deterioration on the cost of installation and the cost of the power necessary to run the blower.

Though, as above intimated, figures are not at hand to indicate the improvement either in output or quality of work in well-ventilated work-rooms, as compared with rooms or factories ill-ventilated, or not at all ventilated, I shall fail in the main purpose of this article if I cannot make a successful appeal to common sense to sustain my view of the case. Would not the cost of such ventilation as indicated in the preceding paragraph be more than repaid in the increased pecuniary return realized in quality and quantity of work? This is the question which must be answered definitely and affirmatively before any general adoption of ventilation as a regular specialized feature of factory plants can be expected. The history of the world's industries affords no encouragement that working conditions will be spontaneously and vitally improved by the mass of employers, unless the latter can see profit in the change.

There is encouragement to be gathered in the effect upon special industries which have been derived from other improvements. It is within my memory and experience that, in a large manufacturing town, a new factory providing itself with nice washing facilities, toilet and wardrobe accommodations, and an elegantly kept lawn and flower garden under the advice of one of the broadest minded and most intelligent mill managers it has ever been my fortune to meet, did, by the liberal expenditure thus advised, become able to get the pick and cream of some ten thousand mill operatives in the town, with, as the superintendent personally assured me several years afterward, advantage that much more than justified the expenditure.

If there is profit in considering the personal cleanliness, convenience, and taste of factory workers, why, in the name of common sense, should there not be profit in considering their health? If ventilation is profitable for a horse-stable why should not a factory be systematically and thoroughly ventilated?

I have met with the following line of argument against the practicability of the proposition:

"In the effort to make factory ventilation popular with proprietors, there will be raised objections the same as, or analogous to, those made by railway managers to car ventilation. Good railway-car ventilation is conceded to be an impracticable scheme. The space to be ventilated is too small in proportion to the number of occupants to admit of a sufficiently rapid change of air without injurious and very annoying draughts. The heat that it is practicable to supply is inadequate to heating fresh cold air in quantity sufficient for good ventilation; and, worst of all, the people differ so in their desires for heat that you can not suit them all in this particular. Some sit in their wraps and overcoats while others remove them. The only way in which to compromise is to disregard the wants of passengers. Do the best you can conveniently, and let people continue to grumble. They will travel, all the same, ventilation or no ventilation. So the factory workers will be glad to get work, ventilation or no ventilation."

This argument, when thoroughly analyzed, is fallacious. If good ventilation would pay, the railways would supply it even if it required a single car for a single passenger. Passengers will not pay, as a rule, for good ventilation. A very large proportion of people occupy but a small proportion of their time in railway traveling, and prefer its temporary discomforts, and risk its injury to health, rather than pay the high fares which good ventilation and comfortable heating would demand. Passengers are not paid for services rendered to railway companies while riding in cars. If they were, the companies would strive to get the most for their money, by getting fullest service.

In hospital wards all in the same ward are served alike in the matter of heat and ventilation. If any wished to wear wraps or overcoats, and then complain of too much heat, they would be required to remove their coverings. Hospital administration is accompanied by discipline. So is factory administration. Railway companies cannot exclude cranks. In this respect a factory has the advantage over even a hospital. As to the difficulties of ventilation in factories, none exist that do not exist in hospitals, and, except in very rare instances where deleterious materials are handled and contaminate the air, one-fourth —or even less—of the amount of fresh air for good hospital ventilation would more than suffice.

The main question is, *"will it pay?"*

I am not alone in believing that it would. Good service—the best of its kind in any sort of mental or manual work—is compatible only with entire relief from other demands upon the vital forces. I do not believe a first-rate editorial can be written by a man whose head aches, or that a painter could paint an immortal picture standing at his easel with rheumatic pain in his knees. But even these uncomfortable pains would be less potent in obstructing high attainments than the languor, lassitude, and want of interest begotten by long confinement in the foul air of an oppressively heated and ill-ventilated room.

We are at the beginning of the twentieth century and the most conspicuous tendency of human activity is to get a maximum result by a minimum of expenditure. Minimum cost of fuel, of transportation, of brain and muscle, must hereafter be considered in the mighty competition that characterizes the commerce of the world. Maximum results include both quality and quantity. To get both of these the conditions must be, even to the smallest, compatible with most successful achievement. Ventilation in factories is one of these necessary conditions. It will repay its cost as well as any other investment in the fitting up of a well-designed factory.

FUEL COMBUSTION WITH DRAFT FURNISHED BY MECHANICAL METHODS.

By William Wallace Christie.

Mr. Christie's first paper, dealing chiefly with the intelligent study of the boiler furnace, appeared in THE ENGINEERING MAGAZINE for March, 1901.

MY preceding article dealt with the essentials of a commercially perfect boiler setting and the conditions to be maintained in operating the boiler plant, leading up to the requirements of economy in the matter of temperature of the flue gases. It was assumed that when the escaping gases from the boiler furnace entered the flue to the chimney their temperature should be 500° F., which in itself represents a waste of heat.

But there has not been great waste in the boiler, and this temperature given for the flue gases cannot be lowered much in the boiler without detriment to the quality of the steam made. The temperature of steam at 60 pounds' pressure is about 307° F., at 100 pounds it is 338° F., and at 150 pounds 366° F.—only 193° F. to 134° F. lower than the flue temperature; hence we must look outside of the boiler itself for prevention of waste after gases enter the flue. We may add to the plant an economizer, practically a feed-water heater, in which the tubes containing the water to be heated are of cast iron, surrounded by the hot escaping gases, the tubes themselves being kept clear of ashes and soot by scrapers operated vertically by a small engine. The economizer, being virtually a section of the flue, is so located that the gases may either pass through it direct or by-pass to the chimney or blower.

From four tests made by Mr. G. H. Barrus, we have results showing that the evaporative efficiency of the boiler may be increased from 7 to 12.8 per cent. by the use of an economizer, as follows:

	1	2	3	4
Temp. of gases lost in economizer, degrees F..........	145	107	104	156
Temp. of feed water raised in economizer, degrees F...	80	66	58	92
Temp. of gases leaving economizer, degrees F.........	231	254	299	279
Percentage of increase in evaporation due to economizer	10½	7	9.3	12.8

The temperature of the gases leaving the economizer, it will be noticed, varies from 231° F. to 299° F. If the gases passed immediately to a chimney the intensity of draft would be in proportion to the absolute temperatures, or for the 500° F. case 961° F., for the 231° F., 692° F., and for the 299° F., 760° F. In a general way the intensity of the draft is diminished by the economizer by about 30 per cent. of what it would have been had the gases gone direct to the chimney; so that to produce the same draft in the economizer plant we should need a chimney say 41 per cent. taller than with the economizer omitted.

On account of this loss of heat, mechanical means are frequently used when economizers are installed, to bring the draft up to what it should be, without increasing the height of the chimney. Sometimes the chimney is cut out entirely, as would be done by some in designing a new plant. The Cheney Bros., South Manchester, Conn., having a chimney 90 feet high, wished more draft than it would produce; they installed a forced-draft outfit, to be used in connection with it, and an economizer. The gases enter the economizer at 475° F., and leave it at 275° F.

Unless the boilers and economizers are designed with special reference to forced combustion, the gases escape from the boiler at a much higher temperature than with natural draft, and we have a loss of efficiency in the boiler which must be made up in the economizer; even then the gases leaving the economizer in a forced-draft plant are not so very much lower in temperature than may be obtained with natural draft.

To burn fuel with forced draft is said to require about 50 per cent. of air additional to the theoretical quantity, or a total of 18 pounds per pound of coal. When natural draft is used, 100 per cent. additional air, or a total of 24 pounds per pound of coal, is requisite.[*]

Now with an outer-air temperature of 60° F.: With natural draft, 1 pound of coal requires 24 pounds air and gives off escaping gases at a temperature 440° F. above temperature. With forced draft, one pound of coal requires 18 pounds air and gives off escaping gases at a temperature 240° F. above atmosphere. To raise 1 pound of air 440° F. requires $0.2377 + 440 = 105$ B. T. U. To raise 1 pound of air 240° F. requires $0.2377 \times 240 = 57$ B. T. U. One pound of fuel with forced draft wastes 57 B. T. U. for each of its 18 pounds of air, a total loss of 1,126 B. T. U. One pound of fuel with natural draft wastes 105 B. T. U. for each of its 24 pounds of air, a total loss of 2,520 B. T. U. So that the actual waste from using natural draft is 1,394 B. T. U. per pound of coal burned. As the heat units in one pound of coal may be taken at 14,200 B. T. U., the heat loss with chimney draft is greater than that with blower (no operating expenses being considered) by 1,394 B. T. U. or $\frac{1394 \times 100}{14.200} = 9.81$ per cent.; but it can be readily appreciated that as the air required to complete combustion, or admitted to the fire, when natural draft is used approaches in quantity that sent through by the blower, there is less and less economy of the former practice over the latter until when the quantities of air become equal there is no difference between the two methods except the additional operating expenses of the blower.

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[*] There is much uncertainty as to just how much air is used at any time, so these figures must be taken with considerable allowance, both quantitatively and comparatively.

There are several mechanical methods of producing draft dynamic in their character, that is, having work expended on or through them; these are:

1. Forced draft.
2. Induced draft.
3. A combination of the above.
4. Forced-natural draft.
5. Steam jet in the chimney or flue.
6. Steam blower under the grate.

In connection with all of these a chimney or suitable outlet must be and is used.

1. Forced draft is simply draft produced by a blower forcing the air through pipes to the ash pit, and up through the coal and so out of the chimney. The advantages of forced draft compared with natural chimney draft are well summarized, in part, by Mr. Jas. Howden of England as follows:

a. Complete combustion of fuel of all qualities under conditions under which combustion could not be efficiently obtained by natural draft.

b. The power of regulating with ease the amount of combustion desired, from zero to many times that possible by natural draft, also the capability of maintaining the fuel in the furnace incandescent for a considerable time without appreciable consumption.

c. A great reduction in the size or number of boilers required to produce a given power, and the capability of increasing the power in steamships far beyond that now obtainable with natural draft.

d. Greater economy in producing steam, under which he names seven causes which I will not give here.

e. Less discomfort in stoking, etc. (marine work).

f. The complete absence of smoke.

2. Induced draft—the production of a partial vacuum at the furnace by the use of a blower located between the boiler furnace and the chimney, sucking the gases from the furnace and discharging them

from its own outlet generally through a chimney, which method is the most chimney-like of draft production.

3. Forced-induced draft is produced by a combination of the two methods mentioned above.

4. Forced-natural draft is secured by the use of a blower to supply the air necessary for combustion to a closed ash-pit, with proper regulation to maintain the desired steam pressure or quantity of air for combustion, while a chimney is used to draw the gases away from the boiler. This system, as well as the others, has produced very desirable results under certain conditions. From tests by Barrus, where forced-natural draft was used we have the following very economical results:

Boiler pressure, lbs. per sq. in.	63	68	70	71
Temp. of escaping gases, F.	346	355	395	400

5. Steam jets and steam blowers as a rule are not employed unless a chimney is in use; while producing draft and aiding combustion to a certain degree, they make a very uneconomical combination.

All of the blower methods of draft production must be considered in connection with, and planned with special regard to, the quantity of fuel to be burned in a given time and the amount of air needed for the complete combustion of the fuel, which air must necessarily pass through the blowers. Pure carbon requires 11.5 pounds of air per pound of carbon for complete or perfect combustion. Coal, both anthracite or bituminous, requires about 12 pounds of air per pound of fuel per hour. With forced draft in operation a dilution of 50 per cent. is advisable, 18 pounds of air being provided per pound of fuel; with chimney draft, 100 per cent. excess, or a total of 24 pounds of air per pound of fuel is needed. One English authority says approximately 20 pounds of air are required per pound of fuel for complete combustion. So that for 100 boiler horse power, made by burning 400 pounds of coal per hour, we should need an air supply of 400 × 24 = 9,600 pounds of air per hour, or 9,600 × 12½ = 120,000 cubic feet of air per hour to be passed through the furance at a velocity of 45,000 feet per hour; we would, therefore, require a blast-pipe area of $\frac{120,000}{45,000}$ = 2.66 square feet, or 383.04 square inches, which would also be the capacity area of the fan. The proportions may be determined from the approximate formula capacity-area = $\frac{D W}{3}$, D being the diameter of the fan wheel in inches, W the width of fan wheel at circumference in inches. We should then have in this case 383 = $\frac{D W}{3}$, or 1,145 = D W. For a 6-foot or 72-inch wheeel, W would equal $\frac{1,145}{72}$ or 16 inches width of fan wheel at circumference; for an 84-inch wheel W would work out to a 13-inch width. The nozzle area should be somewhat larger than 383 square inches, say 22 or 23 inches diameter. The volume of air passing through the fan should be calculated from the capacity area. R. C. Carpenter gives this rule* for centrifugal fans: The number of cubic feet of air discharged in one revolution of the fan is equal to the cube of the diameter of the fan expressed in feet, multiplied by constant 0.5 if there was a free delivery, and 0.4 if the pressure was about that found in ordinary practice, or equal to the pressure of 1½ inches of water, and he shows by the results of an actual test,† "that for that plant, at least, a gain of a good many horse power would have been possible by the substitution of mechanical for natural draft, provided the heat discharged from the flue could have been saved and utilized."

If this heat loss can be taken by an economiser, which I have already referred to, or by a flue heater, we have in addition to its operating expenses that of the blower; for all installations having blowers require power to operate them. This power is obtained either by belt from a main line shaft or from an electrical motor, or, what is usually considered far preferable, by a steam engine or electric motor directly connected to it, or at least on the same frame.

The steam or power used to operate blowers is from 1 to 7 per cent. of the steam made under the boilers; as low a figure as 0.5 of one per cent. has been given. When the economizer is used we should add the expense of maintaining and operating it to the blower expense.

According to Péclet, chimney draft produced by the heat of the gases involves an expense exceeding one-fourth of the combustible used. If the heat in these gases can be utilized, as in the economizer, etc., the more economical mechanical draft may be used, but when no means of utilising the heat is available, it is advisable to employ it to produce the draft in a chimney.

Mr. W. R. Roney‡ says, referring to the designs for a mechanical-draft and economizer plant for 6,000 boiler horse power, with duplicate fans, that the power required to drive one fan was 6-10 of one per cent. of the boiler horse power developed * * * (coal costing $3 per ton) * * * "it would not pay to build the chimney so long as money was worth more than 2 per cent. per annum." If the boiler plant was used at half or double capacity, the fan draft would probably cost all that interest on the chimney would amount to, for money can be had at 4 or 5 per cent. with ease.

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* Eng. Record, p. 354, Vol. 38.

† Machinery, June, 1895.

‡ Trans. Am. Soc. Mech. Eng., Vol. XV.

The efficiency of a fan blower falls off very rapidly when used either above or below the capacity for which it is designed, so that it becomes more than ever an expense when worked under either of these conditions. Theoretically, if the centrifugal-fan speed is doubled, the volume is doubled, the pressure is increased four times, and the horse power eight times.

Mechanical draft may be said to cover a multitude of sins in the original design and installation of steam plants and of their flues and chimneys, and further sins in their use far beyond the original calculation.

Theoretically, under certain conditions using natural draught instead of forced draft with an economizer wastes 9.81 per cent., not counting the cost of operation or fixed charges. But this can scarcely be charged against the chimney, as we have no means of utilizing this heat; in the latter case the economizer has given all the heat possible to the water feeding the boilers.

The nearer the quantity of air supplied to a furnace is to the theoretical quantity required, and the lower the steam pressure carried in the boilers, the cheaper natural chimney draft becomes.*

Chimneys present certain fixed, unalterable conditions of location and erection, which limit their adaptability to changes in requirements. Blowers are out of the way; so is a steel chimney over a boiler. Blowers prevent smoke; so does a proper boiler setting with the air supply regulated in the proper way. Blowers can be regulated; one would think that "damper regulators" had never been heard of in connection with chimneys—in fact many plants are not equipped with them now.

As forced draft used alone gives a higher temperature of the escaping gases than that produced by natural chimney draft, the saving due to a combination of it with the economizer should be credited to the latter alone.

A forced-draft plant at present in operation, without an economizer, heats the steel chimney where it goes through the roof of the boiler house to a dull red heat, or about 1,000° F.; at the Otto Colliery, Branchdale, Pa., cylinder boilers, forced draft, have gases escaping at a temperature of 1,600° F., and vertical boilers, 711-732° F., the evaporative efficiency being low, but higher comparatively (as a poor fuel is used) than originally with natural draft.

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* The effect of the quantity of surplus air on the temperature of combustion in the furnace is for theoretical quantity of air.................. 4940 degrees F. above 32 degrees F.
50 per cent. additional air........................... 3332 degrees F. above 32 degrees F.
100 per cent. additional air.......................... 2505 degrees F. above 32 degrees F.
When the gases are under pressure as in stokeholds of vessels, the temperature of combustion is at ordinary atmospheric pressure............. 2760 degrees F. above 32 degrees F.
At pressure of 2 atmospheres......................... 3475 degrees F. above 32 degrees F.
At pressure of 3 atmospheres......................... 3968 degrees F. above 32 degrees F.

High temperature conditions do not continue after a certain rate of combustion is reached, as shown by the Purdue locomotive tests, with varying grate area and rate of combustion and the same total pounds of coal burned in the same time for each test.

Coal per hour per square feet of grate	61.40	83.50	124.20	240.80
Smoke box temperature, F.	647	629	610	500
Draft in inches of water	2.20	2.50	3.30	5.60

With a chimney alone producing draft we have a heat loss somewhat less than with a blower alone producing draft; to this is to be added the cost of operation of the blower, or from 1 to 7 per cent. With a blower and economizer, giving the same flue temperature as in a chimney and economizer, there is a loss of the cost of operating the blower.

One of the inducements offered to steam users, as in favor of forced combustion, is the saving made possible through the ability to burn cheaper fuel; but this would also be possible in a plant having a chimney designed for the furnace. We are necessarily governed somewhat in our selection of the method to be used in producing draft by the fuel at hand to be burned, but the draft required for efficient combustion even of poor fuels, in the majority of cases, is not outside the limit of that which a chimney of moderate height will produce.

Steam blowers under grates are used in connection with some mechanical stokers, and under boilers whose chimneys have been built too small, or have become so by the inevitable result of expansion in the boiler plant. Steam jets are used in chimney flues for the same reason.

In the emergencies which come to naval vessels, and occasionally to certain steam plants, an undersized chimney will be materially aided by a blower outfit. Then again about 25 pounds of coal per square foot of grate is all that can be burned, advisedly, with natural draft; beyond that forced combustion is necessary. But given a boiler plant with its every detail planned for the work to be done and fuel to be burned, I do not believe that mechanical draft will be anything but an expense over natural chimney draft, and a considerable expense at that.

The life of a fan is probably 15 years or under, when it is ready for the scrap heap. The life of a steel unlined chimney (the cheapest kind) is about the same, while a brick chimney, well-built, should not need expensive repairs before the end of fifty years and should last one hundred years. The cost* of any forced-combustion apparatus or of chimneys depends wholly upon the kind of installation. Good brick chimneys, double-shell, cost from $3.00 to $7.00 a rated boiler horse power; other styles a less amount. Another writer gives the cost of brick chimneys as nearly proportional to the cube root of the area in square feet, multiplied by the cube of the square root of the height in feet.

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* W. W. Christie, in the *Railroad Gazette,* Vol. 32, page 688. See also "Chimney Design and Theory—by the same author.

The fixed charges can be stated more closely and I would consider them to be 12 per cent. for mechanical draft and 8 per cent. for a good double-shell brick chimney; 11½ per cent. for a steel shell, unlined. For small horse power, I believe the guyed steel chimney can be installed for less money than the blower outfit. For large powers, the mechanical apparatus is the cheapest in cost price.

In 1894, W. R. Roney,* in concluding a paper on mechanical draft, says: "I venture the prophecy that the time is not far distant when tall-chimney building will be one of the lost arts, and the progressive engineer will point, as his monument, not to the tall and expensive chimney of the past, but to the comparatively inexpensive and economical draft of the future."

Now in 1901, seven years later we have or find just completed or building these large chimneys:

LOCATION.	HEIGHT.	DIAMETER.	MATERIAL.
Bethlehem Steel Co., Bethlehem, Pa. (1)	175	9	Radial brick.
Bethlehem Steel Co., Bethlehem, Pa. (2)	175	8	Radial brick.
Yorkville Hygeia Ice Co., N. Y.	190	7½	Radial brick.
N. Y. Shipbuilding Co., Camden, N. J.	200	8½	Radial brick.
Great Northern Paper Co., Millinocket, Me.	235	12	Radial brick.
Boston Elevated R. R. Co., Lincoln Wharf, Mass.	251½	13	Common red brick.
Manhattan Railway Co., N. Y.	278	17	Common and radial brick.
Metropolitan Traction Co., N. Y.	353	22	Common red brick.
Orford Copper Co., Constables Hook, N. J.	360	13	Radial brick.

In radial-brick chimneys the diameter of flue is measured at the smallest section; in common-brick chimneys the diameter is uniform.

These instances cover some of the largest American steam installations of immediately recent construction, and being designed and advised by the highest class of engineers obtainable, the fact that the plants have chimneys alone in the majority of cases, while in none of them are blowers used alone, speaks volumes for the chimney still continuing with us for a time, even though it may as in some of the above cases have the company of a blower.

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* Trans. Am. Soc. Mech. Engrs., Vol. XV.

GOLD MINING AND MILLING IN WESTERN AUSTRALIA.

By A. G. Charleton.

III.—WATER PROBLEMS AND THEIR SOLUTION.

Mr. Charleton's series, which began in the February issue of the Magazine, has so far included reviews of the general topography and conditions of the West Australian fields, the chief geological features, and the peculiar process of "dry-blowing" for gold. The present article is devoted to the most characteristic and important problem of the region. It will be followed by a fully illustrated review of mining and milling practice as developed in Westralia.—THE EDITORS.

EARLY in the history of the West Australian fields the question of obtaining an adequate supply of water for mining purposes presented no little difficulty, but various expedients soon suggested themselves by which to overcome the apparent want of this element essential to the development of the industry on a fairly extensive scale.

The ordinary and natural means of obtaining the requisite supply were:

1. By conserving the rain water in dams.

2. By drawing it from natural reservoirs, such as the salt lakes and creek beds, as in the northern part of the colony more particularly (owing to the comparatively heavy rain-fall) fairly large quantities of water are stored in their sandy bottoms.

3. By pumping up the "ground-water," drawn from shafts, bores, etc., which is usually found at the ordinary drainage level of the country, *viz.,* at the horizon where surface oxidation ceases and the relatively harder underlying rocks offer a certain barrier to the further descent of the water, which has penetrated the overlying ground. Below this line, the water generally decreases, and the mine workings are in consequence frequently almost dry.

Conservation in Dams.—A rain-fall of 4 to 8 inches per annum, such as obtains around Coolgardie and Kalgoorlie, will yield a very large water-supply provided any considerable portion of it can be retained, a fall of one inch of rain representing no less than 22,651 gallons per acre, or 14,500,000 gallons per square mile.

The nature of the surface in the catchment area of the dam is, however, a matter of great importance, a heavy shower being necessary to make a surface flow, except on rock areas. But where, as in many parts of the colony, large bare bosses of granite are met with, running from 10 up to 200 acres in extent, they offer a splendid catchment for even the lightest showers. The rain thus collected (as may be seen at the Government dams on the road from Southern Cross to Coolgardie) is caught by cutting a drain around the toe of the rock and leading the water thence to a tank excavated on the lower side.

Some of the valleys, which would otherwise form good catchment areas are rendered useless by the pervious character of their surface soil, as all but very heavy rain is at once absorbed in the ground and does not find its way to the tank. There are, however, certain valleys (generally flanked by low ridges strewn with black-ironstone pebbles), the surface of which is covered with a thin coating of clay, which is impervious to even a straight fall of rain and prevents the absorption of the water by the dry earth beneath. These "clay-pans," formed in natural depressions in various localities, have yielded a large portion of the water-supply that outside prospectors have had to depend upon, and answer the purpose excellently so long as the surface of the ground in the catchment area remains undisturbed. As showing the importance of this latter condition, Mr. J. W. Archibald states* that about a mile southeast of Coolgardie there are two Government tanks of about half-a-million gallons capacity each, and every shower of rain adds to their supply, whilst in two other tanks in the neighbourhood, where the surface of the basin has been disturbed by dry-blowers, only heavy rains will cause any water to flow into the dams at all.

The configuration of the country being generally flat, there are but few sites available where water can be impounded in any large quantity by means of "weirs," and therefore, as a rule, tanks for storage have to be excavated. Mr. Archibald remarks that the sites for these excavations have to be carefully selected and proved by test-holes, as in some cases the greenstone bottom contains small pipes or bores ½ inch to 1 inch in diameter, filled with soluble salts; in cases where their existence has been overlooked, on the inflow of water into the dam an active ebullition has taken place, the soluble minerals being dissolved out of the bore-holes, which then present the appearance of small round holes, with a clean hard casing, and convey the water away to where it is lost in the rocks. Mr. Archibald states that a dam of 500,000 gallons capacity near Coolgardie, filled by a storm in the early part of 1895, was completely drained within 16 hours, and the bottom of the tank showed 83 such holes. This difficulty has been overcome by puddling the bottom and sides of the tanks; in many cases, however, the alluvium in the valley is deep enough to afford tight ground.

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* *The Financial Times*, May 1st, 1896.

The chief objections to this method of conservation are the delay in making a tank and the uncertainty in regard to the time which may elapse before a storm will fill it, and this means of storage met at first with some discouragement owing to the failure of many tanks to hold water, before the nature of the ground was understood and the proper remedies were applied. The Government has wisely, however, voted and laid out very large sums of money for works of this kind.

Natural Reservoirs.—The chain of salt lakes, which run in a north-by-east direction from the head of the waters that flow into the Great Australian Bight on the south through Lakes Cowan, Lefroy, I. O. U., Carey, and Darlot northward, are flanked as a general rule by diorite ridges, intersected by well defined east and west valleys, which through long periods of time have emptied their storm waters into these depressions. They probably owe their origin to a general subsidence of the country, somewhat parallel with the ranges, which were elevated during a period of volcanic activity that doubtless occasioned an extensive series of "faults" along this line of country; and the deep beds of alluvium (the product of the disintegration of the underlying rocks), collected in the lake-bottoms (known as "soaks"), which have levelled up large areas, are now the storing-places of large accumulations of water which they protect from too rapid evaporation. In other places, the rock-bottom lies evenly within a few inches of the surface of the lake, and the loss from evaporation is very great.

Mr. Archibald observes: "Occasionally during the winter months or in time of heavy storms, the surface of these lakes is covered with sheets of water. The surface waters, draining into these lakes for long periods of time, have in their course picked up quantities of soluble minerals derived from the decomposition of the volcanic rocks. The evaporation, which is excessive on such large shallow areas, has caused the precipitation and consequent concentration of the salts in these lakes to such an extent that the water met with in their alluvium is almost saturated, carrying, as a rule, 20 per cent. to 28 per cent. of solid matter. The minerals taken into solution are mostly soluble salts of sodium, lime, and magnesia. Of these the sulphate of lime, being less soluble, was first precipitated out of the saturated fluid on the surface of the lake, the more soluble sodium chlorides being carried deeper into the silt-beds. The crystals, mostly of gypsum, being exposed on the surface of the lake, have by the action of the wind been accumulated in the sand ridges occurring in the low passes between the lakes. In localities where the rock bottom of the lake is comparatively deep, very large quantities of salt-water are stored in the silt-deposits, and they are in places being utilised for milling purposes by opening long trenches through the lakes. The water soaks into these trenches, and is thence conducted to a central pumping station, and although supplies of this nature are dependent on the character of the salt lakes from which they are drawn, under the most favourable conditions large quantities of brackish water may be drawn from such sources. The neighbourhood of these lakes appears also to offer good natural sites for catchment areas of great extent, which hereafter may be utilised for the construction of large impounding-dams for public water-supply purposes."

Ground-water, Wells, Bores, etc.—At different depths down to 200 or 300 feet supplies of water are met with, varying in quantity and quality with the surrounding local conditions. Such water is due to absorption into the rocks of the rainfall during long periods, in places where the surface consists of loose soil (as in the "sand-plains") or where the out-cropping rocks are pervious, and a slow accumulation takes place through the fissures and joints. Consequently, by a careful examination of the surface features and character of the rocks, the points where such wells can be advantageously located may be decided with reasonable certainty.

In the granite rock and gneiss-granites near Coolgardie, Mr. Archibald states there are many such wells, with a daily output ranging from 1,000 to 6,000 gallons per day, situated in most cases near the contact of the granite and greenstones. The water is found in shafts at a depth ranging from 170 to 180 feet, being in some cases fresh, in others carrying as much as 2 per cent. of solid matter. As a rule these rocks have yielded, by their disintegration, the loose sandy soil known as "sand-plains," and the water has percolated through the soil into the more pervious part of the rock until tight ground is met with below, when by putting in drives across the general run of the fissures that carry the water it can be conveyed to a main water-shaft. Mr. Archibald ascribes the comparative freshness of the water in some cases to the fact that the felspars of the granite rocks are more insoluble than those of the greenstones. In the diorite and schists, variable supplies from the same source are met with, but the water generally carries a higher percentage of soluble salts.

In places where soft dykes, reefs, etc., intersect these rocks, or

DRY BLOWING AT COOLGARDIE. THE PROCESS MADE NECESSARY BY SCARCITY OF WATER.

By courtesy of T. A. Rickard, Esq.

where the soft decomposed diorite slates extend downwards to a considerable depth, supplies of water are often struck, however, which are of considerable extent when considered in regard to the small amount of work done in developing them. Thus in the vicinity of Coolgardie, such mines as Cosgroves and Bayley's Consols are stated to produce, from limited developments, 10,000 to 20,000 gallons, and the Hit or Miss Mine, near Kanowna, is said to yield 18,000 gallons daily from above the 120-foot level. Many shafts which are much below levels where water is usually obtained are, however, dry.

When, as frequently is the case, a stratum of harder and impervious rock is met with, underlying the softer rocks where water is found, a well sunk into the impervious rock with drives running out across the strike of the country at this level affords the best means of developing a water-supply of this kind to its fullest capacity, and in some such wells at any rate the production appears fairly constant. Thus the Government well at Coolgardie, Mr. Archibald states, yielded for a couple of years 6,000 gallons per day, and the flow of water did not seem to increase at the time of rain-falls, indicating that the percolation into the shaft, although slow, extends for some distance.

The sinking of other wells in the gneiss-granite within a chain or two of one another does not appear to have affected the supply, and the same may be said of the water-shafts at some of the mines. In certain cases, however, where the rock is more permeable, a diminution of flow takes place when the reservoir is heavily drained, the water gravitating towards the deepest shaft; the only remedy is to enlarge the area of drainage by sinking new shafts.

Bores.—On the Hampton Plains, on Block 49, a diamond-drill bore, located in one of the long east-and-west valleys before referred to, passed through deep beds of alluvium, sand, cement, and decomposed rock, to a depth of 150 feet, and at 170 feet met with hard rock, where a supply of water was struck stated to amount to more than 40,000 gallons per diem. Other bore-holes have been put down with success, near Coolgardie and elsewhere.

General Character of the Water-Supply.—Considering what has been said, it is scarcely surprising that the water of the country generally is excessively salt, almost in fact to the point of saturation, and had it not been for the energetic action of the Government supplemented by private enterprise in establishing "condensing-plants" along the main-roads, to convert the brine of the wells into potable water for man and beast, travel from place to place would have been greatly restricted and conditions of existence in some of the older mining-camps would have been rendered intolerable, postponing the development in all probability indefinitely.

Comparing it with ordinary sea-water, which contains some 3½ per cent. of salts (three-quarters of which is sodium chloride), Mr. T. A. Rickard,* to illustrate the excessive salinity of the water in Western Australia, states that at the Queensland Menzies mine he found them using water in September, 1897, which contained 17 per cent. of salts; and he was informed by the manager that evaporation in the hot weather in December increased the amount to 30 per cent. For this liquid, which came from a neighbouring "soak," 25*s.* was paid* per 1,000 gallons, and the item of water alone for milling, in a ten-stamp mill, amounted to 13*s.* per ton; whilst the condensed water bought for use in the boilers cost 20 shillings per 100 gallons.

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* The Alluvial Deposits of Western Australia. Trans. Am. Inst. of Ming. Engrs.

The chief salts present in a sample of water from the Great Boulder Proprietary, Mr. Rickard considers, were:

	Grammes per Litre.
Calcium Carbonate ($CaCO_3$)	0.145
Calcium Sulphate ($CaSO$)	4.365
Magnesium Sulphate ($MgSO_4$)	5.189
Magnesium Chloride ($MgCl_2$)	15.144
Sodium Chloride (NaCl)	21.467

BUYING WATER AT A CONDENSER IN WEST AUSTRALIA

By courtesy of T. A. Rickard, Esq.

To render water of this description fit for consumption or use in steam boilers it must needs be distilled, and the apparatus used for this purpose, termed a "condenser" in Western Australia, is a prominent feature of every district where a settlement exists or mining is carried on. It might more properly be called a "still," but Mr. Rickard traces the use of the term "condenser" to the sailors who took part in the early exploring expeditions. Any suitable type of boiler can be used for converting the salt water into steam, which is then condensed in vessels presenting a maximum of cooling-surface. In the older condenser plants the general type of boiler used consisted of ships' tanks having a capacity of 400 gallons, which were usually set on edge in pairs. The steam is drawn off from the tanks through short vertical iron pipes, which pass into the condensing chambers or "coolers." The average product of each such tank is about 300 gallons of distilled water daily.

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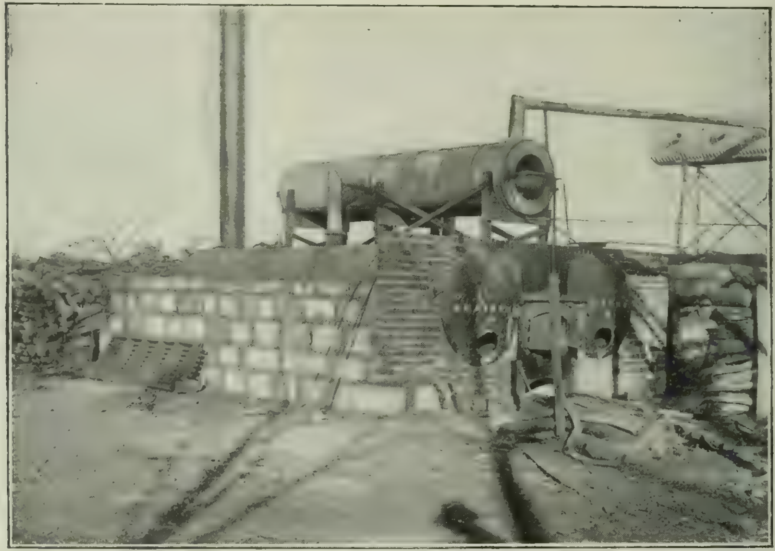
* 10*s.* per 1,000 was, I am informed, paid for salt water in Kalgoorlie in November, 1897, and Mr. Hoover states that as much as 30*s.* per 1,000 has been paid in Western Australia for salt water.—*Eng. & Ming. Journal,* Dec. 17, 1898.

Mr. Rickard states that a first-class condenser plant of this description would require at least eight boilers, giving a daily yield of 2,400 gallons; but the capacity of the plant at some of the mines now runs up, according to Mr. G. J. Bancroft, to 5,000 gallons per diem.



CONDENSER AT THE IRON KING MINE, KALGOORLIE.

By courtesy of T. A. Rickard, Esq.

The coolers at first employed to condense the steam were plain circular towers, about 30 feet in height and 3 feet in diameter, built of sheets of corrugated iron, rivetted and soldered together, and closed at the top and bottom with flat sheets of galvanised iron, several such towers being connected by a 6-inch pipe so that the steam travelled up one and down the next. Annular coolers were next substituted, consisting of an outer cylinder of corrugated iron, 2.5 feet in diameter, surrounding an inner 1.5-feet cylinder, so as to leave a circular space 6 inches wide between them, containing the steam; the inner tube being open at both ends, by tilting the cooler at a slight angle a current of air is made to pass through the centre of the surrounding steam-jacket. A plant of this kind, which cost about £100, was erected some years back at the Lake View and Boulder Junction Mine, and possessed a capacity of 1,500 gallons of condensed water a day. The water which comes from this mine has a specific gravity of 1.03385, the total solids amounting, according to an analysis by Mr. E. S. Simpson, to 4.93 per cent., and the chlorine present to 2.39 per cent.

AN AUSTRALIAN ALLUVIAL CLAIM SHOWING THE CONDENSER.

In plants which have been more recently built the boilers or "evaporators" are either of the cylindrical under-fired class, about 18 feet long, and 4 feet in diameter, like those in use at the Great Boulder, or of an egg-shaped section.

They are provided with necessary fittings and built in like a steam boiler, whilst the fronts are made removable, so as to permit quick and easy cleaning, which is a matter of great importance. Two evaporators of this type supply enough steam to produce 1,200 to 2,000 gallons of fresh water daily. The coolers have also been improved, consisting in some cases of a battery of long galvanised pipes of comparatively small diameter, 4 to 6 inches, cooled* by the surrounding air, connected with steam chests at each end; but more commonly they are formed of galvanised-iron drums (like water tanks) closed at top and bottom, except where the pipe for the entry and exit of the steam joins them together, and contain about five 4-inch pipes, open at the ends, running through them longitudinally and allowing the air to pass through the tubes when the drum is tilted slightly out of the horizontal. This type is also frequently used in combination with vertical water-coolers, similar to the annular air-coolers previously described, but with one end of the interior space closed by a plate, so that when set upright the centre can be filled with water. Pipes are of course provided in the bottom of the coolers for drawing off the condensed water into tanks, where it is stored and cooled.

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* There seems no reason why a nest of pipes of this sort should not be jacketted and water-cooled, using the cold salt-water coming from the mine, thus heating it on its way to the evaporator, by which benefit ought to be derived both ways and the cost of condensation be correspondingly reduced.

Mr. Rickard mentions* that early in 1898 salt water cost 2*s.* to 4*s.* per 1,000 gallons; these figures, however, evidently did not include delivery (which varies with the distance and quantity pumped), and for the period the paper relates to they appear even rather low, as in a paper written about the same time (the beginning of 1898), Mr. Wm. Frechville stated it was selling at 5*s.*, and this was, I believe, about the general price at the shaft's mouth in 1897, although the figure fell shortly afterwards and water could be purchased for 3*s.* 6*d.* at the mines; whilst at the present time (1900) it can be bought for 2*s.* 6*d.*

Without allowing anything for first cost of laying down pipes and pumps (everything else, however, included), salt water was still costing some of the largest of the Kalgoorlie mines 4*s.* 6*d.* per 1,000 gallons delivered, in 1899; and when, as in some cases, the water has to be pumped with a small engine and boiler half a mile or more, the wages paid and wood actually consumed may easily add to the price of the water at the shaft as much as 2*s.* per 1,000 for delivery. In a case of the kind which came under my notice, a 3 foot by 7 foot 6 vertical-type boiler burnt about ⅝ of a cord of hard-wood on two shifts, *i. e.*, 16 hours, supplying steam to a No. 4 Tangye pump, having 3-inch water and 4½-inch steam cylinders, with a 7-inch stroke, and requiring a man on each shift to look after the firing of the boilers. The water is measured by meter.

Mr. Hamilton informs me that 70,000 gallons of salt water per day are supplied to the Great Boulder from various sources, coming principally from shafts on the property and the adjoining leases; it contains from 4.84 to 11.02 per cent. of soluble salts, and exclusive of purchase of water, he reckons it costs a half penny per gallon to condense.

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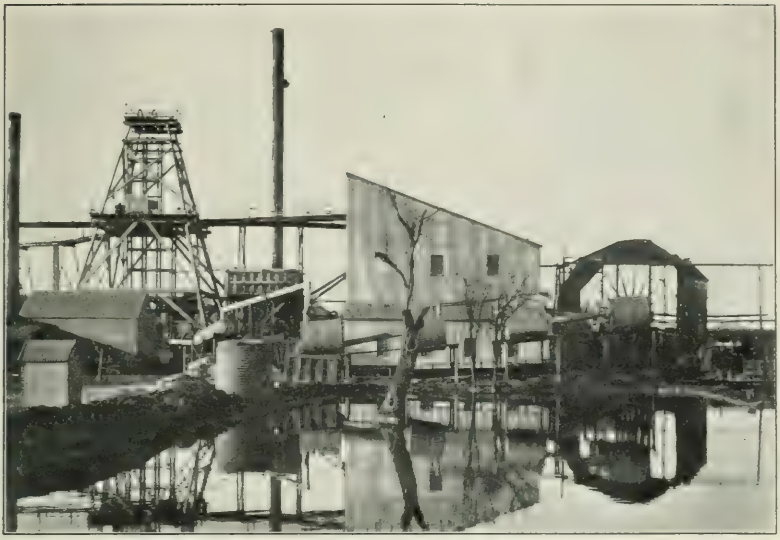
* Notes on a Visit to the Gold Mines at Kalgoorlie, W. A. Trans. Inst. Ming. Met.



GOLDEN HORSESHOE GOLD MINING COMPANY'S PLANT.

Showing storage pond for waste water, with part of the condenser plant.

At the Ivanhoe Mine, I am informed by Mr. Hewitson, the water supply is drawn from a low-lying alluvial flat west of the gold belt, where the company own 76 acres of leased water-rights, on which a shaft has been sunk to a depth of 135 feet and equipped for bailing and pumping water up to the mine, a distance of 6,000 feet, with a vertical lift of 90 feet from the surface of the water area up to that of the mining lease. This furnishes a supply of 40,000 to 50,000 gallons per day, containing about 7 per cent. of solid salts, and is not unlikely to be supplemented by bringing in water from the Hampton Plains Estate. Mr. Hewitson reckons the cost of condensing at £2.5*s*. per 1,000 gallons, but the price varies no doubt somewhat with the quality of the water and the season, as Mr. Rickard stated the average cost in 1898 was about 5*s*. per 1,000 gallons during the cool season and 6*s*. during the summer. The cost of condensing, it thus appears, has fallen from the figure of 1*d*. to 3*d*. per gallon, at which it used to be reckoned, and whilst in November, 1897, condensed water sold for 100 to 150*s*. per 1,000 gallons, or say 12*s*. per 100,* in 1899 the winter price was only about 7*s*. per 100, and 9*s*. in the summer, or an average of 8*s*.

As a basis for calculation, Mr. Hewitson states that on a production of 2,400 gallons of fresh water per day, the expenditure would include the labour of two men (one on each shift), 2½ cords of wood

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* It has fetched 14*s*. and more.

(1 cord of wood per 1,000 gallons of condensed water), and 3,200 gallons of salt water.

Water for drinking and household purposes is obtained partly from tanks which catch the rain-fall from the roofs, but it is apt to become contaminated with salts of zinc and impurities due to dust, dead frogs, etc.

The density of the salt water is no doubt an obstacle to amalgamation, in consequence of the fact that, the ore being particularly liable to "slime," the fine particles can less easily settle on the copper plates, and run the risk of being carried away in the tailings. To prevent the decomposition of the stock-solution in the cyanide works, the magnesia is precipitated with lime. The chloride of magnesium present in the mill-water, according to Mr. H. P. Woodward, tends, however, to sicken the mercury in the mills.

Estimates of the loss of water from various causes are exceedingly variable; thus whilst it is claimed that milling and cyaniding can be done with a loss of 0.25 tons of water to the ton of ore (using the water, of course, over and over again), Mr. Geo. Bancroft estimates that in most of the mills 0.5 ton of water is lost per ton of ore. Even

CYANIDE VATS, NORTH BOULDER MINES.

Showing conservation of waste water behind dams made of tailings.

this, however, appears considerably underestimated. Mr. H. C. Hoover,* putting the average mill, steam, and domestic loss at about 400 gallons of 10 ℔. each per ton of ore milled. When the tailings and slimes are treated, however, he states that some portion of this can be saved, reducing the loss to about 250 gallons per ton of ore. At North Boulder, in October, 1898, the loss amounted to 367 gallons per ton, and in December to 496 gallons.

The ordinary loss is probably therefore actually as Mr. Wm. Frecheville says, between 200 and 400 gallons per ton, although I am informed by Mr. Skews that in the warm weather (owing to the evaporation in the dams) it sometimes rises to 1,000 gallons per ton. Cyaniding alone, according to Mr. Bancroft, entails a loss of 15 per cent. Mr. Callahan considered, I am told, that there was an average difference in consumption in summer and winter of some 300 gallons per ton. It would, however, be interesting and of value to have more complete data on these points, showing under what heads losses occur and what they amount to, under different conditions.

Mining companies generally allow their workmen, if single, 2 to 3 gallons of condensed water a day gratis, and married men 4 gallons, which is regularly served out to them, the water tanks being arranged so that the taps are padlocked, to prevent theft.

It will be clear from what has been already said that, dry as the country appears to be on the surface, there is an abundance of water for carrying on *ordinary small mining undertakings*, but, on the other hand, it is evident that a large and important camp like Kalgoorlie could never expand on a scale commensurate with its possibilities and the value at which mining properties in the district have been capitalised, if it had to depend alone on the sources of supply of which mention has been made, for the simple reason that *large quantities of low-grade ore* could never be worked at a profit.

As it is a well-recognised fact that the success of a mining camp largely depends on its ability to work low-grade ores cheaply, it being far more profitable to do so than to treat high-grade ores in small quantity (which is always an expensive matter), the question of how to solve the water-difficulty (which is perhaps quite as important as the "sulphide problem," if not more so), has long exercised the minds of everyone interested in the West Australian industry. Optimists, whose wishes were the parents of their thoughts, at one time hoped that by putting down deep bore-holes an artesian-supply might be struck in large volume, as in Queensland, but the geological conditions do not seem to favour the probability of this expectation being realised, although it may be that sufficiently large quantities of water may yet be obtained on the Hampton Plains or elsewhere, comparatively close to the gold-fields, to compete with the supply which the Government have arranged to furnish. The Hampton Plains are some 20 miles from Kalgoorlie, and if anything like 500,000 gallons per day should prove to be furnished by the Cane Grass valley works (which it is asserted, there is some likelihood of obtaining), no doubt a private pipe-line may be laid down to pump it to Kalgoorlie.

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* Mining and Milling Gold Ores in W. A. *Eng. & Ming. Journal*, December 17, 1898.

When the Government scheme is carried to completion, however, there is no doubt that it will give an entirely new impetus to mining on the fields, by enabling many mines to increase their outputs and others which cannot now be worked at a profit to resume operations. In California, millions of gallons of water are "flumed" hundreds of miles to various mining camps, entailing enormous engineering difficulties, but this particular project is unique in the history of mining, as it provides for the delivery of 5,000,000 gallons of fresh water daily, which is to be pumped a distance of 328 miles, through 30-inch pipe, with an aggregate lift of 1,313 feet at the eight stations to be established along the line; the lifts generally being through short sections of the line, with long sections of falling grade between them.

The source of supply is the Helena River, which is in the Mt. Darling range, near the coast; a weir, which will dam the river back some 7 miles, forming a reservoir capable of containing 4,500,000,000 gallons, being under construction at Mundaring, about 26 miles from Perth, at an elevation of some 320 feet above sea-level. The weir is being built in a gorge and will be 720 feet long on top and 110 feet high near the middle, made of cement concrete, faced with ashlar work of very hard micaceous granite; the excavation for the foundations of the dam, amounting to 50,000 or 60,000 cubic yards, has been some time since completed.

The pipe line at each pumping station is to be broken by a reservoir, 20 feet or more in depth, holding not less than 2,400,000 gallons, into which the water will flow and from which it will be pumped to the next, the greatest distance between any adjoining stations being less than 70 miles. Between the second and third stations an extra reservoir 25 feet deep, with a capacity of 6,000,000 gallons, is to be located to reduce the head at this point by about 200 feet; otherwise the closing of the stop-valve at the third station would place about 36 miles of main under a head of 450 to 650 feet. The location of the pump-station is such that the head against which the water will be pumped will be practically the same at each of the first four and second four stations, the object being to secure uniformity in the pumping machinery, of which there will be only two sizes proportioned to the two different lifts Triple-expansion engines with surface-condensers are to be used, and it is stated that economy of coal-consumption will, to some extent, be sacrificed to simplicity of design. The water, by this means, will be raised to the top of Mt. Burgess, an elevation of over 1,630 feet above sea-level, from whence it will be distributed by gravity to Kalgoorlie, Coolgardie, Menzies, and other camps.

At Coolgardie there is to be a service reservoir having a capacity of at least 24,000,000 gallons and a number of smaller service reservoirs, and 100 miles of 12-inch distributing mains are included in the project.

The contract for the pipe-line was let in October, 1898, to Messrs. Hoskins & Ferguson, the weight of steel involved (without jointing-rings) being 74,442 long tons. The coating added 3,867 long tons. The contract price for the coated pipe is about £13 per ton f. o. b. Falkirk, W. A., and the contractors are called upon to supply as many welded steel joints-rings as may be required up to 30,926 of such rings at the rate of £.2.6 delivered at Falkirk.

The peculiarity of this pipe is that it is made of steel plates fastened together with two longitudinal locking-bars, made by swelling the longitudinal edges of the plates, and bringing them together in grooves, made in the opposite sides of the bars. The bars are then closed on to the swollen edges of the plates by pressure. The contract requires 1,000 lengths to be 5/16 inch thick and 30 inches internal diameter, and 60,956 lengths to be 1/4 inch thick of similar size. The plates and bars are to be of open-hearth acid steel, the plates to be capable of withstanding a tensile strain of not less than 25 or more than 29 tons per square inch, with an elongation in 10 inches of not less than 20 per cent., and a contraction area of not less than 45 per cent.

The selection of this new form of pipe was decided upon, however, on what appear sound reasons, *viz.,* whilst the engineer's estimate for 330 miles of 30-inch spiral rivetted steel-pipe was £1,068,000, the contractors' tenders for lock-bar pipe came to only £998,000, against which the actual tenders for spiral rivetted pipe of 26, 27 1/2, and 29 inch diameter (which it was at first intended to employ) came to £1,220,000. Consequently the saving in cost thus effected admitted of employing a large-size pipe, without exceeding the engineer's estimate; and all rivets being done away with, as also the changes in the diameter of the pipe every 28 feet (which would have been caused by placing the sections alternately inside and outside each other), the adoption of these pipes ought to decrease friction considerably, and effect a saving in pumping charges, which it is calculated will amount to some £10,000 per annum.

It is proposed to lay this pipe on timber bolsters or sleepers, hollowed to a depth of not less than 6 inches (to fit the under side of the pipe), placed on the ground, and although with a range of temperature of 75° F. the amount of expansion to be provided for is about ⅝ inch for every 100 foot length of pipe, as this is not likely to occur except if the pipes are emptied during extremes of heat and cold, it is expected that expansion joints placed every 120 feet will meet the difficulty. So placed, however, the pipes would offer but little resistance to motion and "creeping" might occur unless prevented, whilst in all curves the joints would have a tendency to move radially from the centre of the curve. To obviate such movements, 3 feet from the end of every fourth 28-foot length of pipe, three 12-inch pieces of angle iron 6 by 4 by ⅜ inch are to be double-rivetted to the under side of the pipe, to bear against piles or a mass of concrete, and piles of concrete blocks placed on the outer side of the pipe on curves.

Stop valves are to be used at the inlet to each reservoir, at the outlets of the pumps at every important depression, and at points not exceeding 5 miles apart. Scour-valves having openings 6 to 9 inches in diameter are to be placed on the under side of the main at every depression.

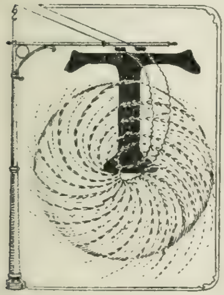
The plan of laying the pipe on the surface is not, as seems generally supposed, new in Australia, as to my knowledge water is pumped from the Burdikin River to Charters Towers in Queensland through a line of this description, built, if I recollect right, in 1888, which supplies the town with water. The reasons which have produced its adoption in this case were: 1, That in a line of such extreme length the question of leakage is important, and as small leaks from the joints and rivets of steel pipes, when subjected to strains caused by expansion and contraction, are certain to occur, they can be easily detected early and thus at once repaired; 2, decreased cost of laying; and 3, the fact that the soil along most of the line contains salt which would induce rust; 4, there is no prolonged frost to guard against, and no difficulty to be apprehended from wilful damage.

The estimated cost of the undertaking, which being carried out by the Public Works Department of West Australia, will amount to £2,400,000; the charge to be made for the water is variously stated at from 2*s*. 6*d*. to 3*s*. 6*d*. per 1,000 gallons.

TRANSATLANTIC COMMUNICATION BY MEANS OF THE TELEPHONE.

By Prof. M. I. Pupin.

Ten years ago, in the first number of this Magazine, Mr. Herbert Laws Webb forecast the possibility of Transatlantic telephony. Dr. Pupin has just devised the effective means for accomplishing this end. It is a striking instance of success in tracing out a mechanical analogy in an allied field. It was well-known that vibrations travelled better in a dense medium than in a rare one. Sound carried better in water than in air; waves travelled further on a hard, heavy cord than on a soft, slack one. But to work out the analogy correctly—to determine the means and manner of loading an electric cable with inductance so that it should correspond to the densified medium and gain increased capacity for transmitting electrical waves—was a signal work of genius. In this article Dr. Pupin gives a general outline of the theory and experiment and a brief concluding measure of its significance.—The Editors.



THE method of constructing cables and long-distance air lines for power transmission by electrical waves, particularly for long-distance telephony and telegraphy, is a practical application of the general mechanical theory of wave propagation over non-uniform conductors.* The main features of this theory can be explained by a very simple mechanical illustration. Consider the figure on the next page. A tuning fork has its handle *C* rigidly fixed. To one of its prongs is attached a flexible inextensible cord *B D*. One terminal of the cord is fixed at *D*. Let the fork vibrate steadily, the vibration being maintained electromagnetically or otherwise. The motion of the cord will be a wave motion. If the frictional resistances opposing the motion of the cord are negligibly small, the wave motion will be approximately that seen in Figure 2. The direct waves coming from the tuning fork and the reflected waves coming from the fixed point *D* will have nearly equal amplitudes, and by their interference will form approximately stationary waves. If, however, the frictional resistances are not negligibly small—if the string, for example, lies along a surface upon which it rubs as it vibrates, or if it hangs slack instead of being under tension between the tuning fork and the point of attachment—then there will be dissipation of the propagated wave energy. Hence the direct and the reflected waves will not have equal amplitudes, and, therefore, their interference will not result in stationary waves. The attenuation of the waves is represented graphically in Figure 3. Experiments may readily be made with a cord lying along the floor, vibrated first in contact with the boards, then just free from them—first under little tension, then under higher tension. Further, experiments will show that, other things being equal, increased density of the string will diminish attenuation, because a larger mass requires a smaller velocity in order to store up a given quantity of kinetic energy, and smaller velocity brings with it a smaller frictional loss. This is a striking mechanical illustration of a wave conductor of high inductance. It should be observed here that an increase of the density will shorten the wave-length.

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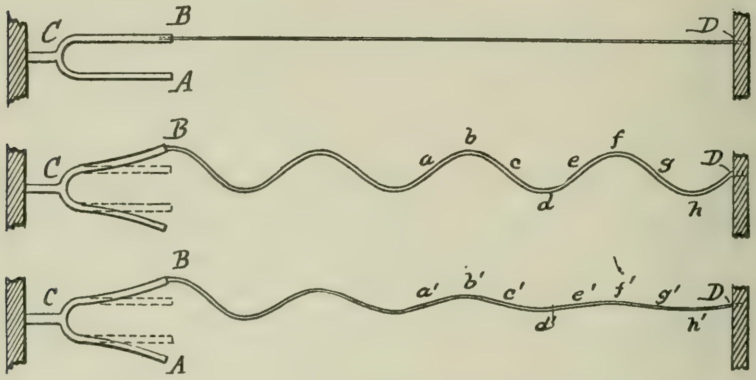
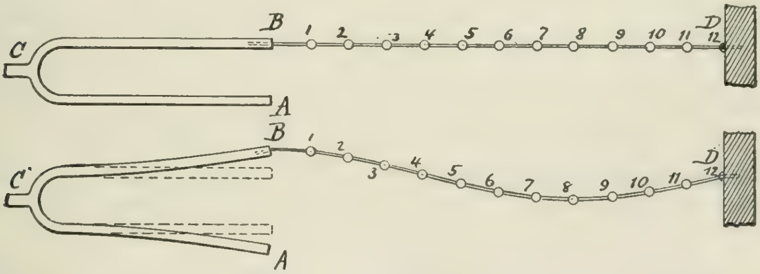
* The first mathematical theory dealing with wave propagation of this kind was presented by Dr. Pupin before the American Institute of Electrical Engineers in Mar. 22, 1899. A more complete development of the theory was read before the same society in May, 1900.



FIGS. 1, 2, 3. VIBRATION OF A CORD WITH AND WITHOUT FRICTIONAL ATTENUATION OF WAVES.

Suppose now that we attach a weight, say a ball of beeswax, at the middle point of the string, in order to increase the vibrating mass. This weight will become a source of reflections and less wave energy will reach the point *D* than before. The efficiency of transmission will be smaller now than before the weight was attached. Subdivide the beeswax into three equal parts and place them at three equidistant points along the cord. The efficiency of wave transmission will be better than it was when all the wax was concentrated at a single point. By subdividing still further the efficiency will be still more improved; but a point is soon reached when further subdivision produces an inappreciable improvement only. This point is reached when the cord thus loaded vibrates very nearly like a uniform cord of the same mass, tension, and frictional resistance. Such a loaded cord with a tuning fork attachment is represented in Figure 4. Figure 5 represents the vibration of a cord carrying loads at proper distances apart.

The problem of finding the proper distance at which the loads should be placed is a definite mathematical problem of analytical mechanics, but unfortunately it was never solved. Experiments with cords of this kind will soon convince one that the distance between the loads should be considerably smaller than one-half of the wave-length of the wave which is to be transmitted, so that though a given cord may be properly loaded for some wave-length, it will not be properly loaded for shorter wave-lengths. It is impossible to load a cord in such a way as to make it equivalent to a uniform cord for all wave-lengths; but if the distribution of the loads satisfies the requirements of a given wave-length, it will also satisfy them for all longer wave-lengths. It should be observed now that the wave-length which is considered here is not the wave-length of the cord without the loads, but the wave-length which the frequency under consideration will have on the properly loaded cord, or what is the same thing, on a uniform cord of the same mass, tension, and frictional resistance as the loaded cord. This point is of fundamental importance, for the wave-length corresponding to a given frequency may and generally will be much shorter on the loaded cord than on the cord without the loads.



FIGS. 4 AND 5. VIBRATION OF A LOADED CORD.

A cord of this kind is a mechanical analogy to an electrical-wave conductor. The mathematical law in accordance with which such a cord moves is the same as that in accordance with which the electrical current is distributed over the wave conductor under the action of similar forces. The reason for that is not far to seek. We have the same reactions in both cases, viz.:—Kinetic or mass reaction, tensional reaction, and resistance reaction in the case of the cord, electro-kinetic reaction, capacity reaction, and ohmic resistance reaction in the case of the wave conductor. The mathematical form of these reactions is the same in both cases, hence one is an exact analogy of the other—the mechanical a counterpart of the electrical. The loading of a telephone wire with induction coils, properly introduced, will increase its capacity for electrical-wave transmission. Wrongly arranged, they will decrease this capacity.

The insertion of inductance coils at periodically recurring points along the wave conductor or wire produces the same effect upon electrical-wave transmission as the distribution of the small loads along the stretched cord of Figure 4 produces upon mechanical-wave transmission along the cord. The mathematical theory of wave propagation over non-uniform conductors of this kind was given by the author in a paper before the American Mathematical Society and can be found in their Transactions for 1900. This theory is, of course, at the same time the mathematical theory of wave propagation over a loaded cord described above. The main object of this theory is to find an answer to the question: *Under what conditions are non-uniform conductors described in these two sections equivalent to their corresponding uniform conductors?* The answer which the mathematical theory gives to the question just proposed is definite. To formulate it introduce here a convenient technical term. Denote the distance between two consecutive inductance points, that is, the points at which the inductance coils are introduced, by l, and let the wave-length which is to be transmitted be λ. Now introduce an angle φ such that

$$\varphi / 2\pi = l / \lambda.$$

The angle φ shall be called the *angular distance* between the inductance points, or inductance sources. The angular distance 2π corresponds to the wave-length. The law which determines the degree of equivalence between a non-uniform conductor and its corresponding uniform conductor can now be stated as follows: *A non-uniform conductor is as nearly equivalent to its corresponding uniform conductor as* $\sin \varphi/2$ *is to* $\varphi/2$.

It is evident that φ is inversely proportional to the wave-length, so that for a given distance between the reactance points the degree of equivalence diminishes as the wave-length diminishes. If a wave of complex harmonic frequency, such as occur in telephony, be transmitted over a non-uniform conductor, then the action of the conductor will be different for the different components of this complex harmonic wave. If, however, the non-uniform conductor acts with sufficient approximation as a uniform conductor toward the highest important frequency of this complex wave, then its approximation to a uniform conductor will be even higher for the lower frequencies and thus for all the frequencies of the wave. A numerical example will illustrate this point more clearly. It is well, however, to state more fully the meaning of the expression "equivalence between a non-uniform conductor and its corresponding uniform conductor." All that we can predicate of a wave of a given frequency is that it has a certain wave-length and a certain attenuation constant. Hence, if a wave of a given frequency has the same wave-length and the same attenuation constant on a non-uniform conductor as it has on the corresponding uniform conductor, then the two conductors are equivalent to each other. If these two quantities differ by, say, 3 per cent., then an approximate equivalence up to within 3 per cent. exists.

Consider now the following numerical example: A twin conductor, such as employed for telephone cables, has a length of 250 miles. Let its constants have the following values per mile:

Inductance = 0.
Resistance = 9 ohms.
Mutual capacity = .074 microfarads.

According to the high but definite standard which the New York Telephone Company employs, the limiting-distance of telephony over such a cable is 39 miles. According to the lower standard which is maintained in long-distance telephone work the limit would be 78 miles. The results obtained by me experimentally seem to verify these figures. I find that at a distance of 100 miles telephony over such a cable is very poor, in fact, impracticable, and at a distance of 125 miles impossible. It is proposed now to decrease attenuation and distortion over such a cable by the insertion of inductance coils at periodically recurring points. The attenuation constant β in this case is given by the formula

$$\beta = \frac{R}{\sqrt{2}}\sqrt{\frac{C}{L}}$$

Say that it is required to have $\beta = .015$. Assume that the introduction of the inductance coils adds 9 ohms per mile, so that $R = 18$ ohms. These values of R and C require $L = .56$ henrys. The attenuation factor at a distance of 250 miles would be $\epsilon^{-250\beta} = \frac{1}{40}$, (roughly). That is, 2½ per cent. of the current leaving the transmitting end will reach the receiving end. This is quite sufficient for telephonic purposes; but it should be observed that better efficiency of transmission could be obtained by making L larger. Notice now that the attenuation factor for this cable without the coils would be, for a frequency of 600 p. p. s., roughly, $\frac{1}{25 \times 10^4}$ that is, with a given initial current, the current at the receiving end would be 6,000 times larger with the coils than without them.

The next step is to find the wave-length for the highest important frequency in telephony over a *uniform wave conductor* having $L =$ .056 henrys, $R = 18$ ohms, $C = .074$ microfarads. The best telephone practice assumes that 750 p. p. s. is the highest frequency of any importance. The wave-length corresponding to this frequency over a *uniform conductor* of this description is obtained from the formula

$$\lambda = \frac{2\pi}{p\sqrt{2LC}} = 14.6 \text{ miles,}$$

approximately.

Suppose now that at each mile we place a coil of inductance $L =$ .056 henry and a resistance $R = 9$ ohms. The angular distance φ for frequency 750 p. p. s. of the non-uniform conductor thus obtained will be $2\pi / 14.6$. The degree of equivalence of this non-uniform conductor to its corresponding uniform conductor is measured by the degree of equivalence of sin $\pi/14.6$ and $\pi/14.6$. Now sin $\pi/14.6$ differs from $\pi/14.6$ by less than one per cent. of the value of $\pi/14.6$; hence for a frequency of 750 p. p. s. the wave-length and the attenuation constant on the non-uniform conductor will differ from the wave-length and attenuation constant on the corresponding uniform conductor by less than one per cent. of the values of these constants. Such a difference cannot be detected by any of the experimental methods which are at present available for investigating wave propagation. In telephonic transmission the ear could not detect it. For lower frequencies the differences will be even considerably smaller. Hence, the non-uniform conductor thus obtained will represent a uniform, non-attenuating, distortionless conductor for telephonic transmission.

It should be observed here that in the case of a submarine cable of say 2,000 miles the attenuation constant should be much smaller than the value of β given above, in order to have a sufficiently small attenuation factor. Now the capacity per mile of a submarine cable is about four times as large as the capacity of the telephone cable just described. Hence, both on account of the long distance and also on account of the much increased capacity, the inductance per mile will have to be much larger than in the case just discussed. But high inductance and large capacity will give a very short wave-length. For instance, if in the case of the submarine cable having six times the capacity we employ an inductance six times as large as in the case of the telephone cable we shall obtain for the frequency of 750 p. p. s. a wave-length of only $14.6 \div 6 = 2.43$ miles. Hence, since the inductance coils will have to be placed apart at one-sixth of the distance employed in the case of the telephone cable, the distance between them will be about 880 feet. The distance between the inductance coils depends entirely on the circumstances of each particular case. But in all cases the rule given above contains the necessary and sufficient directions.

This rule and the method based upon it are recommended by my mathematical theory for the construction of distortionless wave conductors of high efficiency of transmission.

To determine how far the mathematical theory was confirmed by experiment, a so-called artificial cable was constructed. The cable had 250 sections, each consisting of a sheet of paraffined paper. On each side of this sheet was a strip of tinfoil. The resistance of this strip is approximately 9 ohms. The capacity of the condenser formed by the two strips is .074 microfarads approximately; 250 sections of this kind connected in series represent a cable of 250 miles in length, having a resistance of 9 ohms and a capacity of .074 microfarads per mile. The twin inductance coils consisted each of two coils wound on one spool 125 mm. diameter by 125 mm. high, and separated by a sheet of cardboard 1-64th of an inch thick. The coil when finished was boiled in beeswax at a temperature of about 280° Fahrenheit, in order to drive all the moisture out and insure good insulation. Each coil had 580 turns of No. 20 wire B. & S. The average inductance of one of these coils is .030 henry, and the mutual inductance .028 henry. Each coil, therefore, when connected into the line, has an effective inductance of .058 henry.

The connection of the various sections to one another either direct or through inductance coils is controlled by plugs. The plugs being in, the coils are short circuited, and the consecutive sections are connected to each other directly; the plugs being out, the consecutive sections are connected through the intervening coil. The former case gives the uniform cable, corresponding to the unloaded string; the latter case gives the non-uniform cable of 250 miles in length with an inductance coil inserted at each mile, corresponding to the vibrating string loaded with the waxen balls.

The object of the experimental research performed with this cable was to determine the electrical wave produced in it by the action of a harmonic electromotive force. A wave curve of this kind enables measurement of the wave length and the attenuation constant, and comparison of the results thus obtained with the mathematical theory. The work was actually done and it was found that theory and experiment agreed very satisfactorily.

It was shown further that when the distribution of the inductance coils over the cable does not render the cable approximately equivalent to its corresponding uniform conductor, there will be serious internal reflections which will diminish the efficiency of wave transmission.

For this purpose the inductance coils were connected in groups of ten; one of these groups was inserted into the cable every ten miles; the total inductance of the cable was now the same as before, but the distribution was quite different. A simple harmonic e. m. f. of 260 p. p. s. was impressed upon the cable. The wave-length of a wave of this frequency on the corresponding uniform conductor was found to be 41.4 miles, so that the inserted inductance coils were apart at a distance which is equal to about one-quarter of the wave-length on the corresponding uniform conductor. The degree of equivalence between this non-uniform cable and its corresponding uniform conductor is very small. It was found that the attenuation in a cable loaded in this manner was *greater* with the coils than without them. In other words, coils introduced improperly are barriers to electrical waves and therefore they injure the efficiency of transmission.

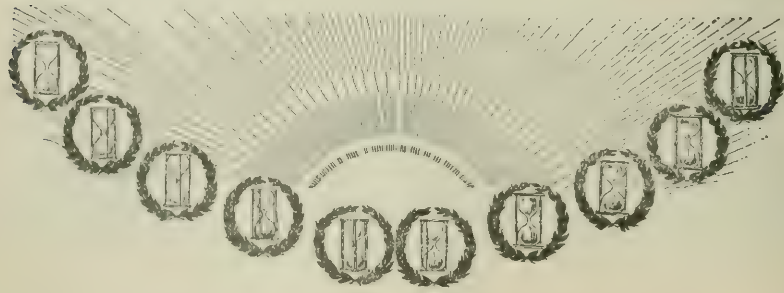
These experimental results left no doubt as to the correctness of the prediction of the mathematical theory. Actual experimental tests with transmitters and receivers which were kindly put at my disposal by the New York Telephone Company, for which I feel very grateful to them, verified these predictions completely. Telephonic communication over the whole of the cable was carried on with perfect ease. Both the volume and the articulation of the transmitted sound were all that could be desired. If, however, the inductance coils were cut out and the cable used as a uniform cable, then the transmission was good up to 50 miles, fair up to 75 miles, impracticable at 100 miles, impossible at distances over 112 miles. Increased distance interferes with the transmission over the uniform cable, not only on account of the diminished volume of the sound transmitted, but also on account of the rapid loss of articulation. This manifests itself at first as an apparent lowering of the pitch of the voice just as the theory demands. My assistant's voice is of an ordinary pitch, if anything a little above the pitch of the average man's voice. When it was transmitted over 75 miles of the uniform cable (that is, the coils being disconnected from it) it sounded like a strong baritone. Over a distance of

100 miles it becomes drummy (this is an expression borrowed from telephone engineers) that is was difficult to understand it, unless nothing but ordinary conversation was carried on and then very slowly, and the speaker had to put his mouth as close to the transmitter as possible and speak out as if he were addressing a big audience. At distances over 112 miles nothing but the lowest notes of the voice could be heard; the articulation was entirely gone. When the coils were all in, then no drumminess in the voice was noticed, and the conversation could be carried on as rapidly as one chose to do. I understand that in long distance work three galvanic cells of the same type of which I had two only were formerly employed by the American Telegraph and Telephone Company when they employed the old system of transmission.

The effect of internal reflection is illustrated even more strikingly by telephonic transmission than it is by the exploration of the waves. The same distribution of coils was used for telephonic transmission as described above in connection with the internal reflection experiments—that is, a group of ten coils each at distances of ten miles apart. A distance of a hundred miles of the cable was employed. Telephonic transmission over this distance was absolutely impossible, although the lowest note in the voice was transmitted quite vigorously, and sounded like the muffled beating of a big drum. Another distribution of the coils was now tried. The coils were divided into groups of five, and these groups were put into the cable at points five miles apart. Transmission over a distance of a hundred miles became intelligible, though with much difficulty; but it was not as good as over the cable without the coils. The drumminess was even more excessive in the former case than in the latter. One had to put his mouth very close to the transmitter, speak very slowly, very loud, and about very ordinary things, otherwise the meaning of the transmitted intelligence would not be caught at all. But if the same distance of cable was employed with the inductance coils placed one mile apart, as the mathematical theory suggests, then the voice of the sender sounded just as if he stood right before the receiving operator. It was not necessary to stand near the transmitter at all, in order to be heard at the other end. There was no difficulty in making the receiving operator understand even if the transmitting operator stood anywhere in the room at a distance of twenty feet or more from the transmitting instrument. The effect of the inductance coils properly distributed over the cable upon the efficiency of transmission astonishes even one like myself who have now worked for years upon and made myself perfectly famliar with this fascinating problem of electro-mechanics. The inductance coils which I employed contained no iron. Coils with iron cores to be used for this purpose will have, of course, to be constructed in a perfectly definite way to work satisfactorily. I expect to bring this matter before the American Institute of Electrical Engineers in the near future. Suffice it to state now that such coils will be required in the construction of non-uniform submarine and underground telephone cables, on account of the much smaller volume per unit of inductance.

The practicability of such coils has been satisfactorily demonstrated in my laboratory, and coils of this kind are now in the course of construction, intended for loading overland lines of 1,800 miles in length. The method has been very thoroughly tested by the American Telephone and Telegraph Company on a line 715 miles in length, and found to work quite satisfactorily. The saving in wire on this particular circuit was about 64 per cent.; but much better results are obtainable. There is very little doubt about the possibility of telephoning by this method over a distance of 4,000 miles, using the present standard long-distance wires, over which telephony is now possible at a distance of 1,000 miles; and there is no reason to doubt the practicability of telephoning across Transatlantic cables properly loaded. The cost of such cables will not be more than 25 per cent. over and above the cost of the cables of the present type. Some mechanical difficulties will be met, of course, but they do not seem to be very serious.

Further, and by no means least important, is the obtainable improvement in telegraphy. A line which is reasonably good for telephony is excellent for rapid telegraphy. The means which would make conversation across the ocean possible would fit a Transatlantic cable for the use of systems of rapid telegraphy, enormously increasing its business capacity. In view of this gain, the additional expense of installation would be a trivial matter.



EDITORIAL COMMENT

OUR TENTH ANNIVERSARY.

Ten years ago, in April, 1891, the first number of THE ENGINEERING MAGAZINE was published. The anniversary is worthy of a notable celebration, not only because of the gratifying success which the Magazine has achieved, but especially because of the timely and telling service which it has been able to render to engineers and industrial managers the world over.

* * *

But I am prompted by weighty considerations to depart from the established custom of celebrating such an anniversary with a special number, an illuminated cover, and the attendant loud blowing of trumpets. The new century was greeted with our Works Management Number, which has scored a striking success because of the world-wide demand for a publication giving, within the covers of a single volume, some really notable examples of successful works management, and also clearly indicating the principles, the methods, and the mechanical equipment of the modern system of highly specialised production. In other words, it met a legitimate demand—it performed a use. And that, I hold, is the only justification for any special number of a Magazine devoted to the interests of "men who do things." For busy, practical men do not buy engineering literature to be entertained. They want information—"working plans available for immediate use," as one of my colleagues has happily phrased it.

* * *

Acting upon this principle, and inspired by an honest determination to have the Magazine render its constituency the highest possible service, I decided a year ago to make this anniversary memorable by publishing in one volume, alphabetically arranged like a dictionary, a complete descriptive Index to the world-wide range of current engineering literature during the five closing years of the Nineteenth Century. The work on this great publication has been progressing steadily, and is now nearing completion. But the magnitude of the task has proved so great that we are denied the happy coincidence of simultaneous publication with this number of the Magazine. For this occasion, therefore, I can only say that the prospectus of the work, showing sample pages, will be issued during the coming month, and within about ninety days we hope to be able to deliver the completed volume. Its definite aim will be to make all the really valuable literature of this fruitful period available for all time; and as evidence of the professional spirit which animates the work, I cannot do better than quote my colleague, Mr. Suplee, under whose personal direction the idea is being carried out. Writing in these pages recently, he said:

> It is related that King George III. once made the remark: "I have had occasion to consult the best lawyers in my dominions, and the ablest of them can do no more than refer!" He might well have said the same of a wider subject than the law; and what would have been true at the close of the eighteenth century is a thousand-fold truer at the close of the nineteenth.
>
> The Engineering Index enables the engineer to refer, with a fullness and promptness which without its aid would be impossible; for no matter how fully a professional man may know his standard works of reference, it is a physical impossibility for him to keep in touch with the latest and fullest form of professional information—the current technical periodical

press—except through the medium of such a record. With the completion of the third volume of the Index, now in course of active preparation, there will be placed in the hands of the engineer a retrospect of the work of the closing years of the century, which, unlike others to which reference has been made, will be of permanent value and usefulness, alike a record of the past and guide for the future.

* * *

But if this great Index volume is to be the enduring monument to the Magazine's first ten years' work, I am sure that our readers will also share the pride and pleasure that we feel in drawing attention to the remarkable continuity of plan, purpose, and method which have characterised the Magazine from the beginning. Thus, of the contributors to our first number ten years ago, Messrs. Atkinson, Saunders, Clarke, Going, and Allen are all once more represented in this initial number of our second decade. And then, as now, they treated subjects of foremost importance in the engineering and industrial world. Mr. E. E. Olcott, M. E., Mr. Edward P. North, C. E., and Mr. Peter T. Austen, Ph.D., F. C. S., were also among our original contributors, but pressing engagements rendering it impracticable for them to join our present company, their places have been worthily filled by the timely contributions from Messrs. Charleton, Christie, and Ford; while in Prof. Pupin's great invention, now described by himself, we have the realisation of an idea fully discussed in an article which formed a leading feature of our first number. This completes our programme for this issue.

* * *

It is also interesting to make record of the fact that, in the first prospectus of the Magazine, issued simultaneously with the appearance of the first number, I used the following language:

> It is a Magazine giving the best thought of the best minds in the engineering and mechanical professions, and it is written for and read by men of affairs who are actively engaged in our greatest enterprises.
>
> The writers have attained honourable celebrity in connection with the subjects which they treat, and being thus written by eminent men in the professions rather than by an individual editor, it is common ground upon which all meet upon a footing of perfect equality; and as such it is indispensable to the active man who desires to keep abreast of his profession.
>
> Each issue also contains a complete review of everything worthy of note that has occurred during the preceding month in the entire field which the Magazine covers; and accompanying this is a complete list of every noteworthy publication that has appeared in the numerous technical papers published on both sides of the Atlantic. The latter feature alone makes the Magazine worth its cost to every man who has need to keep in touch with the times.

This reads so much like a prospectus of to-day, and so exactly describes the present plan and policy of the Magazine, that it seems nothing short of remarkable to find that ten years of varied and often trying experience in conducting a high-class publication for a world-wide audience of technical experts, has developed no sound reason for a radical departure from the original conception. The Magazine has indeed improved vastly in the character of the matter which it presents; the leading articles are selected with far more logical continuity; and the practical value of the great array of information which it presents each month shows a long advance over the average of earlier years. But in form, in typography, in method, and especially in central purpose, it is to-day substantially what it was in the beginning. And in view of this it seems a fitting occasion to say something of why I have been able to succeed in a field where my predecessor failed.

* * *

The first monthly magazine devoted to engineering science was established by Mr. David Van Nostrand, the founder of the widely known technical publishing house, The D. Van Nostrand Co. In January, 1869, he issued the initial number of a publication which was entitled:

VAN NOSTRAND'S
ENGINEERING MAGAZINE

It was an octavo of standard magazine size, set in brevier type, two columns to the page, closely resembling our review department pages; and the subscription price was five dollars a year. During the first twelve months it averaged 96 pages each issue, then dropped to 80 pages, and so continued until December, 1886, when its publication was abandoned. Throughout the entire seventeen years it was highly technical in character, abstract mathematics and military science being largely represented.

* * *

The lessons of this experience were not lost upon me. I saw plainly that Mr. Van Nostrand was a successful publisher of technical books, rather than a professional editor; and that he had made the natural, but fatal, mistake of supposing that a current monthly magazine could carry a burden of abstract technicalities, interesting only to students and specialists, and properly belonging within the covers of text books. I also saw that the great modern school of scientific writers led by Darwin, Spencer, Huxley, Tyndall, and Büchner had wrought a revolution in thought *by simply making themselves clearly understood.* In the beginning, therefore, I confidently flung to the breeze these legends.

> "Men who belong neither to the highest nor to the lowest intellectual spheres, often infer want of depth from perfect clearness. They find comfort and support in abstract and learned phraseology."—*Tyndall.*
>
> "Disquisitions which cannot be understood by every educated man, are not worth the printer's ink that is spent on them. What is thought clearly can be expressed clearly."—*Büchner.*

And in the early prospectus graced by these quotations—mottoes which should be engraved upon every engineer's memory—I wrote this:

These names (a list of our contributors) sufficiently indicate the high level upon which the Magazine is conducted, and the peculiar force of its appeal to the great audience of intelligent men who are actively engaged in the varied industrial enterprises of our time. Such readers have neither taste nor time to pore over abstruse disquisitions. The bridge engineer is no more concerned with the technicality of the metallurgist's laboratory, than is the railway manager with the formulæ of stresses and strains. In like manner the mechanical engineer leaves electrical terminology to the electrician, just as an architect would consign bacteriology to the sanitary engineer. But skilled experts, all alike, meet on common ground with the man of business in demanding a straightforward, business-like statement of essential facts. The end to be accomplished, the principles involved, the cost of construction, the capacity when finished, the sources of income—these are all matters of first interest to all classes of intelligent men, and in the conduct of THE ENGINEERING MAGAZINE everything is subordinated to the single aim of meeting the requirements of this diversified, numerous, and world-wide constituency of practical men-of-affairs.

* * *

Again in 1897, when the European Edition of the Magazine was formally established, after a careful study of the exact requirements of the European field, I said, with much emphasis:

It is important to understand that the Magazine is radically different from every other technical publication. Instead of competing with any one of them, it gives a monthly digest of what is published by each and all of them. Instead of devoting itself to some special branch of engineering, *it is highly specialised* in the all-important work of recording the progress of engineering science *in all its branches* and *throughout the world.* Instead of imitating or duplicating the work of other journals, it has made for itself a distinct place in engineering literature. It has been able, therefore, to establish a position of world-wide influence and circulation, solely because it renders a needed and valuable service which no other journal more than pretends to afford.

Recognising, also, the intense and laudable patriotism of every British engineer, and seeing the necessity for giving the Magazine a permanent abiding place on British soil, as part and parcel of British technical literature, I took care to explain wherein the London edition would be localised and distinct from the American Edition, and "from the first page to the last would appeal directly and positively to the interest of European readers." Then I went on to say:

But it must not be understood from this that the scope of the Magazine is to be limited by either national or geographical considerations. On the contrary, the *world is its field,* and to make the world's best engineering practice available everywhere is its central purpose. Every day gives proof that engineering science is not circumscribed by national boundaries. Every year sees an enormous increase in international trade—in the interchange of methods and appliances. All applied science is a matter of plain business—a matter of pounds, shillings and pence. "The largest yield at the lowest cost" is the motto of success, and the greatest engineer is he who first adopts and successfully applies the best that genius and invention have discovered—no matter whence its origin.

Obviously this is true Anglo-Saxon gospel—a gospel which every clear-headed man is proud to own. For with British commerce unfettered, and with her markets at home and abroad open wide in welcome to all comers, we have the realism of that grand philosophy which has proved that the fittest will surely survive. And what is the teaching? Great Britain is a very bulwark of political stability and security, and every day and hour sees her manufacturers solving the industrial problem by simply taking the best that America and Germany have to offer—in methods, in machinery, and in raw materials.

"For always in thine eyes, O Liberty,
Shines that high light whereby the world is saved;
And though thou slay us, we will trust in thee."
John Hay.

* * *

Happily, too, Britain's example is now hastening the dawn of a better day. America is fast coming to see that what she needs is, not paternalism and political meddling, but wider markets. And Germany's young Emperor, also, has suddenly "changed the *rôle* of war lord for that of the promoter of enterprise and the foster father of commerce." In short, as my colleague, Mr. Going, has eloquently written:

The action of the three great powers in China is a clear acknowledgement that the leaders of thought and action see their fundamental interests to be identical. The great commercial rivals appear as political allies. Antagonism wanes as emulation waxes. The theorem that one nation's ruin is another nation's gain, has gone into the scrap-heap with other dead dogmas of political economy.

The hero of the future is the captain of industry, not the captain of armies. The struggle is to produce the most, and most cheaply—not to destroy the most and the most quickly. The keynote of success, the secret of power, is economy—economy in production, in methods, in management. Before engineers and managers lies the duty of meeting the conditions—and the other great duty of using their influence and power in the affairs of the nation, so that justice and wisdom may govern the State at home and abroad.

* * *

Thus, at the end of ten years' work THE ENGINEERING MAGAZINE is proud of the record of having done much, not only to make current technical information available through its Index system, but, especially, to broaden the scope, to impart vital interest, and to attach public importance to the literature of engineering science. For to my mind industrial literature has now become more important than all others. Take out of the world we live in the work of Watt, Stephenson, Fulton, Morse, and Bessemer, and what would civilisation be? Little more than the Dark Ages left behind. Take out of the present and future the thrilling hope of such work as living engineers and inventors are doing, and what would the prospect be? Let thoughtful men answer. Verily ours is the literature of great men of the past whose thought has wrought a revolution in civilisation—the literature of living men whose work will emancipate the race by enriching the earth—the literature of those who think only to act—and in doing the world's most essential work; make all other things possible.

JOHN R. DUNLAP,
Editor and Publisher.

NEW YORK, *April, 1901.*

REVIEW OF THE BRITISH PRESS

Official Obstruction of Electrical Progress.

ATTENTION has been called in numerous instances, both in these columns and in leading articles in the Magazine, to the retarding influence which has been exercised upon the industrial progress of electricity in Great Britain by official conservatism. We now have a scathing paper by Professor J. A. Fleming in the *Nineteenth Century,* showing the stifling effect which official obstruction has produced, and calling for relief in no uncertain terms.

Rapidly reviewing the marvellous progress which has been made in electricity since 1870, Professor Fleming says:

"In 1870 the dynamo machine, by which an electric current is produced from mechanical energy, was still in process of evolution. The electric arc lamp was a laboratory instrument. The electric incandescent lamp, of which there are now four millions in use in London alone, was non-existent. The telephone was merely an inventor's dream; quadruplex and multiplex telegraphy were unsolved problems; the possibility of creating electric waves, though conceived by the genius of Clerk Maxwell, a mere theory. Hertz, world-famous for his experimental researches on their production, was a boy at school. Marconi, who has applied them in wireless telegraphy, was not yet born. Röntgen had not given the surgeon a new eye by which to see bones and bullets in the living tissue. Ideas on the subject of electric supply stations, electric tramcars, electric railways, electric transmission of power, telephone exchanges, the electrolytic production of caustic soda, bleaching powder, or the electrical production of pure copper and of aluminum, now all vast industries, had not arrived or had only floated in faintest outline as pleasant dreams through the minds of hopeful inventors. They were then all far off as realised facts."

Since 1870 Gramme has produced the continuous current generator, and Hefner-Alteneck, Zipernowsky, Ferranti, Tesla, Ferraris, and their successors have brought the generation of electricity to its present state of perfection.

Electrical storage has grown from the fundamental work of Planté and Faure; transformers developed from the ideas of Gaulard; arc lighting made commercially practicable by Brush, and incandescent lamps produced by Edison and Swan. The telephone was produced by Gray, Bell, and Edison, and the microphone by Hughes.

Close upon this pioneer work in electrical development came the enormous business development in connection with telegraphing, telephoning, electric lighting, electric traction, electric power-distribution, etc., until a whole world of new industry has grown up based entirely upon the commercial exploitation of electricity.

Bearing all this in mind, Professor Fleming remarks upon the meagre number of English names in this list of pioneers in electrical development, and maintains, most truly, that it is not from lack of ability. The truth is that it is from lack of incentive, or to put it more strongly, it is from deliberate destruction of incentive.

As a most conspicuous instance of official interference, Professor Fleming goes somewhat into detail into the manner in which the Post Office has succeeded not only in levying a toll of 10 per cent. upon the telephone receipts, but also practically blocking nearly every improvement in the electrical communication of intelligence, because of the entire monopoly which it holds. As he puts it: "The Post Office possesses the sole right to transmit intelligence by electrical means in return for payment, not merely as the art was then known, but by all and every method which the wit of man could or might through everlasting ages devise."

The telephone in Great Britain, therefore, has to pay a toll of 10 per cent., and the service it at the same time hampered by the opposition of the Post Office to the telephone company's efforts to secure proper rights of way-leave.

The story of the development of wireless telegraphy is another example. For eighteen years the Post Office has been experimenting with the inductive system, only to succeed in communicating between points a few miles apart by the use of parallel wires greater in length than would be required to span the distance. In four years Marconi has succeeded in communicating across the channel over a distance of ninety miles and has made numerous successful applications of the electric wave system well-known to every one. With all this practical success in evidence the Post Office still delays in acknowledging or using the demonstrated system and continues "experimenting" with the older method.

Electric lighting is another case in point. "In 1882 electric lighting began to be an industry, and the Board of Trade, in the person of its then President, the Rt. Hon. J. Chamberlain, deemed it necessary to provide that promising but infant industry with a complete suit of legislative swaddling clothes, in the shape of the Electric Lighting Act of 1882. Assuming apparently that the great aim should be to nip in the bud any tendency to the upgrowth of a monopoly rivalling perhaps those of gas and water, the Act of 1882, ironically termed an Act for 'facilitating' electric lighting, was formed to meet this fear. It provided in its notorious purchase-clause that a Local Authority or municipality should have power at the end of twenty-one years to purchase compulsorily an electric-lighting undertaking at the then value of its plant and works, without regard to goodwill or present or future profits. On this basis capitalists would have nothing to do with the public supply of electricity as a business, and hence for six years electric lighting in Great Britain remained in a torpid, semi-comatose condition. Then began an agitation for an Amendment Act. In 1888 Lord Thurlow, speaking in the House of Lords on the Bill for this purpose, remarked that, as a consequence of the Act of 1882, not one of the sixty-four Provisional Orders for electric lighting, granted by the Board of Trade up to that date, had been put into operation. Yet at that time there were 120 stations in the United States paying dividends of 6 to 14 per cent.

The Act of 1888 altered the purchase period from twenty-one to forty-two years. Investors then obtained a fair chance for the profitable employment of capital, and from and after that date electric lighting has advanced in the United Kingdom by leaps and bounds."

A similar case of throttling legislation has acted to choke off the development of electric tramways, a compulsory purchase clause at the end of twenty-one years at a valuation based upon the mere price of materials, plant, and works at the date of purchase effectively deterring investors from enterprise.

"Hence, whilst for fifteen years the business of electric traction in the United States has been in a position to command and nourish in its service the best inventive talent, we in Great Britain are only beginning to move. We find now that we have to go for much of our knowledge and for many of our materials and machines to the experienced inventors and manufacturers in the United States. They are past masters in the art; we are just learning the business."

"If electrical invention is not to languish in Great Britain, some reforms seem necessary. Public opinion must be brought to bear more strongly through the Press and Parliament upon the administration of Imperial and Local Governmental Departments which are in the practical control of electrical monopolies. The conduct of municipal bodies to new electrical enterprises must be continually criticised. A stronger public opinion must be created on the value and immense national importance of scientific research and invention. Professor Perry has recently emphasised this necessity in an eloquent address to the Institution of Electrical Engineers. All electrical inventions are based upon a scientific knowledge of the facts of Nature. One object of scientific research is to provide the necessary exact information which lies at the root of successful applications in the arts. The late Professor Huxley once declared that if a young Faraday could be purchased in the open market for the price of a first-class battleship, the purchase would be a bargain. For all we know he may he had for nothing, but we must first make an enivronment suitable to foster inventive genius, and not permit it to be repressed by educational or legislative conditions."

Metal Mining in India.

THE great importance of the mining interests of India renders the papers of Dr. John W. Evans before the Society of Arts, published in a recent issue of the *Journal* of the society, worthy of notice and comment, although space here is lacking for an adequate discussion of the subject. Indeed, Dr. Evans himself is obliged to limit his treatment to Peninsular India, and to omit reference to the whole question of the iron deposits of India.

After a brief notice of the geology of the country and some remarks as to the unimportant deposits of lead, zinc, tin, and silver, Dr. Evans refers to the long worked copper mines, and then passes on to his main subject, the gold mines of India.

There seems to be little doubt that the southern part of the peninsula is identical with the land from which the ships of Solomon brought gold, and evidences of ancient workings, both of auriferous sands and of deep workings, are many and important. Vast quantities of gold have doubtless been taken from these old workings, and as only a small proportion of it can be accounted for as plunder of conquerors and the export of commerce, much must still remain hoarded in all parts of the land.

The auriferous tracts of Mysore are discussed at length, both from the geological standpoint and also with regard to the rise of European mining in the district. In this connection the story of work of Mr. Lavelle, and the skill and persistence with which he and his successors, the Kolar Concessionaires, pushed the sinking of their shafts until the old workings were reached, forms a most interesting episode. From 1882, when the output was valued at but £38, down to 1889, with its record of £1,678,090, the total product of Mysore foots up £10,636,687.

Dr. Evans gives some space to accounts of the efforts to develope the Wynaad and the Chutia-Nagpur districts, showing how the brilliant hopes originally raised were doomed to disappointment, and then proceeds to discuss the future prospects of gold mining in India.

Intelligent forethought and scientific method are above all important. No surface reefs may be expected except those which were too poor for the ancient miners to work, and hence prospecting must be done by intelligent drilling, and the diamond drill may be used to advantage in this work. Modern methods of treatment should also be applied, the ore being analysed and the methods employed modified accordingly. In some instances the cyanide process may be employed to advantage, but frequently the pyrites should be concentrated on a vanner and smelted.

Commercial success demands that economy should be secured in every direction. The ores are not rich, fuel is dear, and the cost of labour is great. Mining materials imported from Europe are dearer in South Africa, on account of the higher freight to India, while at the same time the natives are prone to the excessive use of explosives.

An additional cause of expense is the necessity of sending the gold home to be refined. Formerly it was taken by the Indian mints, but an excessive accumulation of gold in the treasury compelled the government to offer less favourable terms.

If investors are careful to see that the values of mining properties are, as far as possible, tested before the purchase is completed; if moderate prices are paid to the vendors, if the mines are carefully and scientifically worked, and the expense reduced to the lowest point, we may hope even yet to see gold mining a prosperous industry, not only in Mysore, but even in some localities in the Wynaad, Bellary, Haidarabad, and in other parts of India.

Light Lathes and Screw Machines.

AN important department of modern machine-tool design formed the subject of a paper recently presented before the Institution of Mechanical Engineers by Mr. John Ashford, and from the interested manner in which it was discussed and the increased introduction of such tools in British workshops, the paper demands review and comment. Mr. Ashford begins by saying:

"Many changes have taken place during the last few years in the methods of machining in our various engineering establishments and manufactories—changes which are necessary in the march of progress, and which we must and do recognise as essential in order that we, as a country, may maintain our position in the manufacturing world. These changes in machining methods usually accompany modifications in the schemes of works management, the object being to systematise the output of work, so that prime costs may be reduced to the lowest point, while the quality of the productions, as regards both accuracy of size and fineness of finish, may be all that can be desired. In order that these new schemes of organisation may be satisfactorily worked, and all requirements of the new order of things fulfilled, there has been a demand for machine tools which in themselves shall fit into the scheme, be more handy for their work, be capable of producing numbers of an article exactly alike, be automatic, where possible, in their action, and shall require little skilled attention. That the changes in themselves are great may be realised when we consider to what an extent milling processes have supplanted shaping and slotting, and, more especially, hand-finishing; how grinding is now used for finishing work that has previously been turned; and that at present automatic machines are being introduced for producing machine parts in quantities which had hitherto to be made by skilled men at a much higher cost.

In what manner these methods originated it is difficult to say; but in all probability they were first introduced in the manufacture of watches and clocks in large numbers; then in the production of small arms, sewing machines, typewriters, and the like; and later in the construction of cycles. Engineers have now without doubt recognised the fact that similar methods may be employed in the manufacture of larger machines, locomotives, and even bridges and ships. These changes have not been suddenly brought about, although to some it may appear so; but they are, in fact, the result of steady progress. To those who have not kept abreast of the progressive movements, the changes may have been forced upon their notice with unpleasant suddenness by the experience of foreign competition. Probably there are establishments with which some of our members are connected, where it is realised that alterations in the producing plant must be made; yet there is hesitation in making the heavy outlay necessary before they have thoroughly considered the matter, and are satisfied as to the results likely to accrue.

"That the matter is serious is evident from the fact that in certain manufactories whole shops have been cleared of their machines, and a complete new and up-to-date plant installed."

Mr. Ashford well says that the ordinary lathes with which manufacturers were satisfied ten years ago do not fulfil the requirements of the present day. The necessities of the present time demand machines which may be more smartly worked, be more handy, and cause less loss of time. Bearing these requirements in view, he enumerates the various conditions which must be met, both for the general lathe and for the turret lathe, emphasising the successive points by illustrations drawn from examples of machines by leading British, German, and American builders.

Space is here lacking to display and compare the machines presented in the paper, these comprising the tools of such well-known makers as Jones & Lamson, Lodge & Shipley, and Hendey-Norton, in America; Herbert, Ward, Humpage, Jacques & Pedersen, in England, and Pittler, in Germany, but the real force of the paper was not so much the comparison of the machines themselves, as a presentation of the necessity and importance of such machines in general.

In the course of the discussion the main points of criticism brought out were the superior strength of the English machines, and the superior convenience of the American tools. The question of automatic machines was well stated as follows: The ordinary lathe needs skill to run it; the automatic machine needs brains to start it, after which it can be maintained in operation by a less experienced man.

It is just this important feature that the modern machine tool must have to be successful, but it is a question as to how far the diminished skill requirements will be permitted to act in view of labour conditions. In the United States, where automatic machines are employed, and have been in full and most successful use for years, it is distinctly understood in labour circles that they are for the very purpose of enabling high-class work to be performed by comparatively unskilled labour. In this respect they bear much the same relation to non-automatic machines as the self-acting lathe, with its slide rest and screw-cutting gear, bore to its time-honoured predecessor, the hand lathe. An important feature in the training of a skilled mechanic in the old days was the knowledge of how to chase screw threads with a hand tool, a form of skill now practically obsolete, even among the highest skilled mechanics. In the very near future the use of the skill and judgment of the machinist for the determination of a size or a fit must become equally obsolete, and for light work, at least, the machines described by Mr. Ashford are destined to play an important part in the transformation.

It must be remembered that a very important portion of the cost of the product is that due to the so-called "fixed charges," and that this must be apportioned in proportion to the time consumed in the production of the article. For this reason the rate of production affects the cost to a far greater degree than is indicated merely by the wage charge, and unless such automatic machines as Mr. Ashford describes are worked to their full capacity the great benefits obtainable will not be realised.

So far as the attitude of the manufacturer is concerned it is beginning to be realised that a machine is only a means to an end, and instead of inquiring minutely into the details of design the purchaser is content to leave such features to the maker, only demanding assurances as to the cost and quantity of the product. "Tell me how much it will cost by your machines to turn out so many thousands of the things I make; then I will reckon up what it would pay me to invest in this way, and we shall be in a position to trade."

American Competition.

In a paper recently presented before the Newcastle-upon-Tyne Association of Students of the Institution of Civil Engineers by Mr. George Harrison Sheffield, some reflections upon American competition are given with a degree of thoughtfulness, and freedom from prejudice, which makes it desirable to make brief discussion of them here.

Mr. Sheffield very justly compares the tendency of individuals toward fixity of ideas with advancing age, to a corresponding tendency on the part of nations. Their views become retrospective, and comparisons are based upon former standards. Such a frame of mind is by no means wise in approaching the subject of competition such as must be admitted to exist between England and America, so Mr. Sheffield goes straight to what he conceives to be the causes of American success. These he classifies under four heads: (1) The successful exploitation of the natural advantages of the United States. (2) The indisposition on the part of British manufacturers to adopt new appliances and to dispense with obsolete machinery; together with the difficulties which they have to face in the matter of railway freights and trade unionism. (3) The psychological characteristics of the American and English peoples. (4) The effects of the municipalisation of industries.

As an example of the natural advantages of the United States, the description of the great iron ore deposits of the Lake Superior district and the manner in which they are worked, as contained in the paper of Messrs. J. and A. P. Head is given, and it is shown that on January 1, 1899, the cost of a ton of pig iron was £1 less at Pittsburg than at Middlesbrough, while the cost of shipment to England was only about 13 s. per ton. This marked difference is due not only to the presence of the ore deposits, but also to the remarkable manner in which they are worked, using steam shovels of five tons capacity per lift, and capable of filling 25-ton wagons in 2½ minutes; with corresponding economies in hauling, reloading, and shipping. This is but one example of the successful exploitation of natural advantages.

The indisposition of British manufacturers to adopt modern equipment is asserted by Mr. Sheffield on the basis of his own inspection of many works. Firms advertising their ability to undertake important work are found to be quite unfit to carry out their offers economically, by reason of their antiquated tools and equipment. In many instances machines varying from 30 to 40 years old are pointed to with pride as having paid for themselves many times over and still being capable of doing good work. The practice of scrapping tools and other machinery as soon as it is found unequal to competition with later appliances is well known in the United States, and the contrast in England in this respect is noteworthy.

As an example of the growth of a single branch of American mechanical industry attention is called to the fact that the annual output of four or five American locomotive works is nearly 5,000 engines, while it is a question if the annual output of all the locomotive works in Great Britain exceeds 1,000, although England should be in a position to supply all the demands of her colonies and dependencies. This is but one example and there are many others which might be cited.

As to the psychological difference between Englishmen and Americans, Mr. Sheffield calls attention to the wide sense of perspective and sanguine vitality which causes the American to seize quickly upon indications of coming changes and to act promptly and with a full grasp of the situation of affairs, not only in his own country, but in all parts of the world.

The stifling effect of municipalisation has been discussed elsewhere, but Mr. Sheffield makes some points which are too true to be omitted. Why, he asks, should a body of men, largely composed of retired tradesmen, be supposed to be gifted with a genius for municipal government? Are they by their education and training, and their conflicting interests, best fitted to grapple with the ordinary problems of modern municipal work, apart altogether from the larger responsibilities they wish to take upon themselves? Municipal progress should synchronise with industrial development, but that synchronisation is stultified if the definition of municipal progress is construed into meaning municipal training.

In conclusion Mr. Sheffield says:

"With the beginning of the twentieth century we have entered upon a new phase of industrial progress, and to the initiative of American manufacturers we owe the precedent for eliminating the individual units of ownership and the merging of them into homogeneous bodies known as trusts and combines. The result is apparently justified by the reduction of expenses and the standardisation of several classes of work.

"We are told that in this country it is impossible to adopt American methods, because they are suitable only to their surroundings. As our products will have to compete with theirs in the same markets, this statement is not altogether convincing. For if honest combinations in this country serve no other purpose than the suppression of obsolete works, they will at least have attained a step in the right direction.

"It would be selfish to suppose that we have a perferential claim upon the world's markets, although this was anticipated when the great principle of Free Trade was adopted. At that time, and for many years afterwards, we accepted raw material from other countries in exchange for which we supplied them with finished products, and so established what was virtually a monopoly. With the development of the resources of other countries there has arisen the natural desire to foster the growth of industry by converting those resources at home in order to avoid a loss of intermediate profit. Hence, the establishment of Protection and bounties in many of our former markets.

"To our Colonies we must look for the greater part of our future over-sea trade, and very recent experience has shown us that even they are not prepared, and rightly so, to penalise their prospects by paying exorbitant prices for the sake of patriotism.

"There is no lack of indication that we are approaching a time of commercial depression of unexampled severity; and during that depression I am convinced there will be a revolution in the methods of conducting many of our industries. The tenacity of purpose that has helped us to weather many industrial storms will, I hope, assist us in this case, and we shall emerge from that depression with a substantial improvement in the national welfare."

The Function of Specifications.

A RECENT editorial in the *Engineer* discusses in a rather pertinent manner the question of the draughting of specifications for engineering work by consulting engineers and engineers in the service of corporations, and in this connection proceeds to examine the real function which such documents are supposed to serve.

"A specification is supposed to be a statement of the nature of something which the engineer wants made, prepared for the guidance of the firm or individual who proposes to make it. The specification may be a detailed description of the thing, accompanied by working drawings; or, alternatively, it may be merely a general indication of what the wishes of the engineer are. A very wide opening is given for abuse. On the one hand, the engineer may oppress the contractor; or, on the other hand, the contractor may defraud the engineer—or, more strictly, the engineer's clients. With these facts, however, we have nothing to do just now. We are about to suppose that the specification is honestly drawn, according to his lights, by the engineer, and that the contractors are willing to work to it in the spirit as well as the letter. Under just these conditions the specification may be most harmful. Roughly speaking, those concerned in specifications may be divided into two classes. The one consists of a limited number of professional men who are constantly drawing up specifications and placing orders; the other consists of a number of firms who carry out contracts under specifications."

Some engineers may be very competent scientifically, but very incompetent in dealing with their fellow men. This is shown by the fact that in many instances the engineer for a railway may design and specify a dozen bridges of nearly similar span, and yet make them all different, thus throwing away for his clients all the advantages to be obtained by repetitive work. Then again, no attention is paid to commercial sizes of material which may be in the market, and large increase in cost must necessarily follow.

It may be stated as a general truth that no one is fit to prepare a specification for bridge work who is not completely informed as to the best modern methods of building up bridges, the capacities of the tools employed, and the sizes of steel bars and plates that can be regarded as always in the market. That engineer will do best who knows how to avail himself of the materials and appliances most readily obtained; and that engineer will do worst who at every step demands special sizes, special materials, and special tools. In the present day these things are wholly unnecessary.

Another great defect in specifications is the minute description of the construction to be adopted, coupled with a requirement for a guarantee of performance. Thus, in connection with a specification for a pumping engine, the indicated power was stated. The dimensions of the cylinders, the pressure, the kind of valve gear, the ratio of expansion, were all given, and finally the contractor was to guarantee the consumption of steam per horse per hour. We need scarcely say that the order was never placed under that specification. An engineer is justified in stipulating for power and consumption; but he must leave the details of the way in which the steam is to be used to those who are asked to guarantee a given economy of fuel under heavy penalties.

These are only a few instances which warrant the engineer in stating that a specification is an edged tool, and that it may, when improperly handled, be as dangerous as it is useful when rightly employed.

Power Plant at the Glasgow Exhibition.

From a lecture recently delivered by Mr. Thomas Young before the Glasgow University Engineering Society some interesting notes are obtained regarding the power generating and transmitting exhibits at the coming Glasgow exhibition.

Steam will be generated at pressures of 120 pounds, and 160 pounds per square inch, a variety of boilers being installed. The lower pressure will be generated in four Lancashire boilers, using mechanical draft on the Sturtevant system, the gases being drawn through a Green economiser on their way to the discharge flue. Water-tube boilers are to be represented by two types, the Stirling, with small, nearly vertical tubes, and the Babcock & Wilcox, the latter being fitted with superheaters. One of the Stirling boilers will be equipped with a Vicars mechanical stoker, and the other fired with producer gas. The total boiler equipment is estimated at 5,000 horse power.

The engines will be of typical British design, there being two Willans & Robinson engines of 1,500 h. p. each, one attached to a Crompton and the other to a Schuckert dynamo. Engines will also be exhibited by Davey, Paxman & Co., Roeby & Co., Ruston, Proctor & Co., and Belliss & Morcom, and others, all of these driving direct connected electrical generators.

As at Paris, there will be little or no belting in evidence, the engines producing current by direct-connected generators, there being two circuits, at 250 and at 500 volts pressure. The various operative exhibits will be able to receive current to operate motors for the power they require, and thus the whole question of power distribution is vastly simplified over what it has been at previous exhibitions.

The arrangements for varying the methods of firing, as well as the completeness of the equipment for weighing fuel, etc., should render it possible to make interesting experiments as to the various efficiencies under operating conditions.

Mr. Young gives many interesting details of the steam auxiliaries, including feedwater heaters, oil separators, pumps, reducing valves, etc., and it is anticipated that the entire power plant will be most complete and efficient. It is especially interesting to note that it is confidently asserted that the equipment will be in complete working order on May 7, the date set for the opening of the exhibition.

The Fulham Destructor Plant.

In a very complete description of the Fulham municipal electricity supply works in a recent issue of the *Electrician*, some interesting details are given of the destructor and steam raising plant.

Twelve standard Horsfall destructor cells are arranged in connection with six Babcock & Wilcox boilers, and are capable of efficiently destroying 120 tons of refuse in 24 hours. The boilers are equipped with mechanical stokers so arranged that either coal or destructor heat can be used, and as it is important that steam be maintained at all times, provision is also made for hand firing in case of emergency.

By the use of powerful steam jets a very intense combustion is maintained in the destructor cells, and the escaping gases are drawn over the hottest part of the furnaces, thus fully cremating them before they are discharged.

It is expected that the destructor gases will suffice to maintain a pressure of 160 pounds in the boilers up to a certain point, but it is not anticipated that they will suffice for the heaviest loads. Still it is estimated that the amount of refuse passed through the destructor per year will be approximately 40,000 tons, and its calorific value is placed at one-twentieth that of good steam coal, there being a saving, therefore, of the cost of 2,000 tons of coal yearly.

The capacity of the plant, in view of the growing demand for electric light and power, has been made considerably above that which will at first be required, the station, exclusive of spare plant, being capable of supplying a total of 30,000 eight candle power lamps.

The capital outlay amounts to over £100,000, and the contracts entered into are as follows:

Buildings, comprising destructor house, engine-room, offices, and transformer chambers, also a small building for public disinfecting purposes....................	£22,970
Refuse destructor, steam-raising plant, inclined roadway, and chimney shaft..................	16,760
Generating plant, including steam-pipes, condensing plant, mains, etc., and apparatus for the above-mentioned disinfector building...	46,000

Additional contracts for the supply of coal-handling plant, and meters, well-sinking, extra foundations, and engineering expenses increase the total to £108,000.

The installation of the electricity supply works at Fulham, in connection with the destructor plant, enables residences in the vicinity of that portion of London to be provided with electric light, and as the neighbourhood is filled with flats of all sorts and kinds, it is anticipated that there will be ample demand for the current, while at the same time the problem of refuse disposal will be wholly and satisfactorily solved.

REVIEW OF THE CONTINENTAL PRESS

The Action of Tides in Harbours.

THE various theories of the tides have been developed upon the assumption that the body of water under consideration is of indefinite extent, or in the case of a river, of indefinite, unobstructed length. Such conditions do not exist in fact, and with the possibile exception of the Amazon, there is no river or inlet of sufficient length to be influenced by more than one tidal wave at a time. The action of the tides in estuaries, harbours, and rivers, must therefore be studied by actual observation; and a very complete examination of the subject, by the well-known Director of the French Lighthouse Service, M. Bourdelles, appears in a recent issue of the *Annales des Ponts et Chaussées.*

M. Bourdelles examines briefly the theories of Airy, Saint-Vemant, Bazin, and Levy, and shows their insufficiency to solve the practical problems. He then takes up certain well-known cases, such as the transmission of the tidal wave of the Red Sea through the Suez Canal until it is dissipated at the Bitter Lakes; and of the tides in the bay of Morbihan, in Brittany, showing in both cases how the behaviour of the tides is almost entirely subordinate to the conformation of the basin in which the wave is propagated, varying, to a great extent with local conditions.

As might be expected, one of the principal causes of local influence is found in the friction between the wave and the channel through which it is propagated. This is especially manifested in the well-known case of the Bay of Fundy, between Nova Scotia and the coast of New Brunswick, where the retardation of the wave, due to friction, causes great differences of level to be produced within comparatively short distances.

Another cause for variation in the action of the tide is the slope of the coast. Examples of this are found on the ocean coast of France and on the gulf of Gascony. Here there is a gradual slope until depths of 150 to 300 metres are reached, when there is a sudden drop of 4,000 to 5,000 metres. The result is an accumulated tide upon the shallow sloping shores, making the rise greater upon those portions than at other points where the deep water comes close to the land.

Thus the equinoctial tide at the mouth of the Adour, where the deep water is close in shore, is 2.90 metres, while at Cordouan, not far to the north it is 4.90 metres, and at Ouessant it reaches 7 metres! The difficulty of obtaining accurate knowledge of the submarine coast conditions makes it impossible to draw exact conclusions, but the general influence of the change of depth is very apparent.

Another question to be studied is the action of conditions tending to vary the velocity of propagation of the tidal wave. This velocity is dependent upon the energy of the wave and upon the frictional resistance of the channel. When the depth is sufficiently great to render the frictional resistance negligible, the gradual narrowing of the channel and diminishing depth both combine to increase the velocity as well as the amplitude of the wave.

The propagation of the wave is modified by friction, the effects of which increase with the square of velocity of the current and inversely with the mean depth of the bed. These effects counteract the energy of the wave to a greater or less extent according to circumstances, or may neutralise it altogether.

In considering the action of the ocean tide upon entering a river, it is not always easy to determine just where the mouth of the river actually begins. The mouth, however, may be regarded as being at the point where the modification of the tide is perceived, this generally being the location where a bar is formed. When a channel is dredged through a bar it has little or no influence upon the propagation of the tide unless the cutting is much wider than merely necessary for the purposes of navigation.

M. de Bourdelles examines the action of the tide with regard to the effect upon the river bed and banks, and shows, by reference to many examples the inconveniences resulting from a powerful and uncontrolled tidal action. In order to provide satisfactory navigable channels which shall maintain their depth and location it is most desirable that sufficient cross section, and especially sufficient depth, be provided for the volume of tidal wave. Sudden changes of direction or section are disadvantageous, and the ideal channel is one of ample depth, confined between parallel dikes, with the cross section gradually diminishing from below upwards.

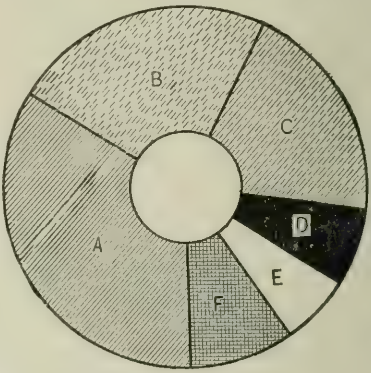
It is rarely that the ideal conditions can be attained in this, or indeed in any engineering problem; but with the exhaustive discussion of M. de Bourdelles as a guide, the nearest approximation which local conditions will permit may be determined, and in many cases the best lines for harbour improvement be worked out.

The Coal and Iron Industry in Russia.

THE gradual entrance of Russia into the industrial field of competition may be in some measure indicated by the development of the coal and iron industries, and for this reason a recent paper of Dr. Neumark, prepared after a journey of investigation in central and southern Russia, and published in *Stahl und Eisen,* demands review and comment.

Reliable information as to the beginnings of the Russian iron industry are lacking, but the earliest record is of furnaces in the vicinity of Tula, in central Russia, from which the industry spread to the Urals and to Siberia. In the time of Peter the Great the so-called College of Mines was officially established, and the industry became an object of special legislation.

Without going further into historical details, the growth of the two industries of pig iron and coal is given in tabulated form from 1880 to 1899, showing the total yearly output of pig iron to have risen in that time from 449,000 tons to 2,700,000 tons, an increase of 600 per cent During the same time the coal production had grown from 3,289,000 tons per year to 13,104,000 tons, or more than 400 per cent. Since 1899 the Russian iron industry has passed that of France and taken the fourth place, after the United States, Great Britain, and Germany. Comparing the rate of increase during the last fifteen years, Russia holds the first place and the United States the second. The general proportion of pig iron production of the world for the year 1899 is shown in the diagram, the relative actual outputs and percentages being as follows:



	Tons.	Per cent.
(A) United States.....	13,839,000	34.10
(B) Great Britain......	9,454,000	23.28
(C) Germany	8,029,000	19.77
(D) Russia	2,703,890	6.67
(E) France	2,567,000	6.32
(F) All other countries.	4,017,110	9.87

The rapid increase in Russian iron production has been mainly due to the remarkable developments in southern Russia, where the production has increased 1,000 per cent. in the ten years from 1889 to 1899, and where 50 per cent. of the entire Russian output is made.

The Russian ores are principally brown hematite and sphaerosiderite, and are mined in a very primitive fashion. The hematite occurs in banks and hills, from which it is dug by the peasants and hauled to the neighbouring furnaces, while the sphaerosiderite is found in the Jura clay, usually at depths of ten to fifteen metres, from which it is raised by shafts and windlasses. The ores run from 35 to 50 per cent of iron, and are easily reduced, and from the moderate content of phosphorus are well adapted for foundry use and for open-hearth steel making. In the Ural region are large deposits of magnetite containing as high as 66 per cent. iron, as well as extensive beds of brown hematite, these nearly being in open workings and mined by cheap labour.

An important element in the development of the iron industry of southern Russia is that of the coal basin of the Donetz. The carboniferous formation as at present worked, lies on the right side of the valley of the Donetz, and extends east and west for a length of more than 350 kilometres, with a width sometimes attaining 150 kilometres, the area of more than 30,000 square kilometres exceeding that of all other European coal districts. The coal basin consists of three levels of massive limestones and sandstone containing numerous rather thin seams of coal, none being more than 2 metres thick, and ranging downwards to 60 to 75 centimetres (about 24 to 30 inches) in thickness. In some cases the seams lie close to each other, in other cases they are separated by more than 400 metres. The coal itself is of widely-varying quality, from the poorest, with more than 40 per cent. of non-combustible to the anthracite with but 2 per cent. The coke production naturally also varies, ranging from 50 to 90 per cent.

Dr. Neumark gives a detailed examination of each district, with tables of both iron and coal production, for which the original article must be consulted, and in concluding he gives a prediction concerning the future of the Russian iron industry Notwithstanding occasional reverses, the general rapid progress will undoubtedly be maintained. The consumption of iron per capita is yet far lower in Russia than in Germany, the former being in 1899 only 28.9 kilogrammes, and the latter 128.4 kilogrammmes. As the internal industries of the country are developed, the iron production will necessarily advance to meet the home market. The reduction in price with increased production will help to encourage the home consumption, and the adoption of improved methods of working will also contribute toward the same end.

Dr. Neumark takes occasion to comment upon the necessity for an acquaintance with the Russian language for the conduct of business with the interior of Russia, and notes that the bulk of the business is controlled by French and Belgians rather than Germans because of the unfamiliarity of the latter with the language.

The Sterilisation of Water by Ozone.

Nearly two years ago reference was made in these columns to the process of MM. Marmier & Abraham for the removal of pathogenic bacteria from drinking water by the use of ozonised air. At that time the process was in an experimental stage, but further experience has demonstrated its practicability, and a paper recently presented by M. Abraham before the Société Internationale des Electriciens, and published in the *Bulletin* of the Société gives some interesting details of the process as at present operated.

After reviewing the earlier processes for water purification, such as boiling, filtering through unglazed porcelain, slow sand filtration, etc., M. Abraham shows that these are either too expensive, or only partially efficacious. Boiled water is flat and tasteless, and even with multiple effect or regenerative apparatus the cost is prohibitory on a large scale. Sand filtration, practically applicable, removes only about 95 per cent. of the bacteria, which, although a great proportion, still leaves sufficient to produce disease. Chemical methods of purification depend mainly upon oxidation, and hence the use of ozone appears to be the ideal method. The first experiments in the use of ozone for sterilisation were made in 1891 by Dr. Frölich, with the aid of Messrs. Siemens & Halske, at Berlin. The success of these experiments led to the appointment of Dr. Ohlmüller, of the Imperial Sanitary Bureau, to make an official report upon the sterilising effects of ozone. Exhaustive laboratory experiments with cultures of anthrax, typhus, cholera, etc., demonstrated that prolonged contact of the water with ozone totally destroyed the germs.

The experiments, however, were conducted only upon a laboratory scale, and although it was proved that ozone was entirely efficacious as a germicide, it was not considered practicable to effect the operation upon large volumes of water, mainly because of the difficulty of insuring complete contact of the water with the ozone. In 1893 ozone sterilisation was undertaken on a large scale by Baron Tindal and the chemist Schneller, in Holland, and the apparatus was shown at the Hygiene Exposition at Paris in 1896.

The difficulty with all attempts lay in two features: lack of concentration of the ozone, and imperfect contact of the water with the ozone. These points were taken up by Marmier & Abraham in 1895 and their first trial convinced them that success was to be obtained by employing a high degree of concentration of the ozonised air, by maintaining a sufficiently long contact of the water and the ozone, and by the effecting of a molecular contact.

The latter condition is obtained by using a form of absorption tower, similar to the Glover or Gay-Lussac towers, well known in industrial chemistry. The earlier attempts simply delivered the ozonised air into a tank in which the water was kept in a state of agitation, but this does not give sufficient thoroughness nor duration of contact.

The production of the ozone is effected by methods differing from those well-known in the laboratory by modifications required by the larger scale of operation necessary. When two plates, separated by a layer of air, are charged electrically with a sufficiently high difference of potential, there is produced a silent discharge, accompanied with the production of ozone. In order to prevent the formation of an arc there may be interposed a dielectric, usually a plate of glass, between the metal plates, and if a current of air be drawn continuously through the space between the plates it will be charged with ozone to a degree depending on the surface of the plates and the difference of potential. If such an apparatus is energetically operated the plates become heated, and hence it has been found necessary to make them hollow, with a circulation of cooling water passing to carry off the heat. The use of water-cooled electrodes appears to have originated with Tisley, in 1874, and was subsequently adopted by Siemens & Halske, and is a feature which renders the apparatus commercially practicable, as otherwise the required area of electrodes would be prohibitive.

The general arrangment of the plant at Lille is as follows:

The electrical current is generated by an engine and dynamo on the premises, and the pressure is then raised by a transformer to 30,000 to 40,000 volts, and delivered to the ozoniser. A fan is arranged to draw air through a dryer and deliver it through the ozoniser, where it becomes charged with 4 to 5 milligrammes of ozone to the litre, and then enters the absorption tower at the bottom, meeting in its upward travel the water which falls from above. The sterilised water is then pumped directly into the reservoir.

The report of the plant at Lille shows that all the pathogenic bacteria in the raw water were destroyed by the ozone, and most of the organic matter oxidised. A few germs of *Bacillus Subtilis* alone resisted the action of the ozone, this microbe also resisting a temperature of 110° C., but as this is altogether harmless to man or beast its presence is considered immaterial.

The cost of the process necessarily varies with local conditions, but it appears that one h. p. hour will produce 20 grammes of ozone, and that 5.8 grammes of ozone are required per cubic metre of air. The quantity of air required for a given volume of water depends upon the impurity, but may doubtless be kept at a minimum by employing sand filtration for the removal of the greater part of the bacteria, the ozone being used only for the final and complete sterilisation.

Electric Tramways in Germany.

The usual annual statistical review of the progress of electric tramways in Germany, appearing in the *Elektrotechnische Zeitschrift,* gives a very comprehensive view of the progress of this important department of engineering industry.

The reports upon which the statements are based bring the record down to September 1, 1900, and include not only such roads as are in actual operation, but also those under construction and those projected.

The year included in the report shows excellent progress, many of the important plants reported as under construction in the previous yearly statement now being in active operation, besides which numerous new projects are under way. These various departments are very fully tabulated, with details giving date of opening, system of operation, whether overhead or underground conductor, or accumulator, length and gauge of track, number of vehicles, and data concerning the power stations. For these the reader must be referred to the original, but a summarv, particularly in comparison with the progress of preceding years, will be of interest.

The total number of centres of electrical tramway operation has increased from 88 in 1899 to 99 in 1900, a gain of 12.5 per cent. the track length (single and double) having been extended during the same period from 2,048 to 2,868 kilometres, an increase of 40 per cent. The increase in electrical output of stations has been nearly in proportion to the increase in track, having risen from 52,500 to 75,600 kilowatts, or 44 per cent. Nearly all of the tramways are supplied with curent from their own generating stations. It is, however, difficult to ascertain the exact proportion of the energy generated which is applied to tramway driving, since in nearly every case current is also used for lighting and other purposes. In many instances the station furnishes current both for traction and for general lighting, and there is a comparison of the two services and deduction of current used for purposes other than tramway driving. By taking the energy in kilowatts per kilometre of track, averaged from 70 tramways in which the current is used only for traction, a comparative estimate is made for those supplied by general stations, these results being probably quite near the truth.

The increase in the use of accumulators, whether for direct driving or for equalisation of load in generating stations, has not been nearly so great as in the previous year, showing a gain of about 25 per cent., instead of 164 per cent. The total generation of electrical energy in Germany, both for lighting and power, at the beginning of September, 1900, was 322,550 kilowatts, or about 440,000 horse power, being an increase of 38 per cent. over that of the preceding year. The general efficiency of electric tramway driving has not greatly changed, the mean of 70 roads, referred to above, being about 20 kilowatts per kilometre of single track, or about 15 kilowatts per motor car.

So far as distribution and pressure of current are concerned there has been little change. The overhead trolley construction, either with sliding or roller contact, is in almost universal use, although in some cities the mixed system of overhead trolley and accumulator is in use, notably in Berlin, where some underground conductor is also used in connection with the two preceding systems.

Only three cases are given in which the driving is wholly by accumulators, but two of these are sections of the main lines of the Bavarian State Railways, each between 50 and 60 kilometres in length.

But a single example of the third-rail construction is recorded, the Wannseebahn, 12 kilometres between Berlin and Zehlendorf.

The statistics show Germany to be decidedly ahead of other European countries in respect of electric tramway development, but as compared with the United States it is still far behind, there being only about one-eighth the track mileage. The rapid development in Germany, however, shows that the advantages of the electric tramway are becoming more and more fully appreciated, and there is every prospect that the extension of electric driving to main line service is being most seriously considered.

The Formation of Boiler Scale.

One of the most obstinate substances found in boiler feed water, so far as the formation of scale is concerned, is sulphate of lime. Not only is it of frequent occurrence, but the scale formed by it is stony, adherent, and difficult of removal. It has generally been assumed that sulphate of lime diminishes in solubility as the temperature of water is elevated, and it is frequently stated that it becomes practically insoluble at 140° C., or about 284° F. As a matter of fact, however, reliable data concerning this point have been lacking, and hence the study by M. Boyer-Guillon, in a recent issue of the *Revue de Mécanique,* with an introduction by M. J. Hirsch, is an important contribution to the science of steam engineering.

After a brief review of the limited amount of published information upon the subject, M. Boyer-Guillon proceeds to describe the apparatus and methods of experimental observation employed by him. The first device consisted simply of a small glass receptacle containing the solution of sulphate of lime suspended in a glass tube through which a current of steam was caused to flow at a known pressure. The precipitation of sulphate of lime could then be observed in the inner receptacle, while the temperature was deduced from the pressure. This method was found to be defective because of the formation of a silicate of lime upon the walls of the glass receptacle, and also because it soon appeared that the precipitation depended upon the element of time as well as temperature. A more elaborate apparatus was therefore devised in which a solution of sulphate of lime could be subjected to heat for any definite time, while a special form of filter immersed in the solution retained the precipitated crystals, while permitting the liquid to pass. The result was checked by a chemical anaylsis of the liquid. The difficulty of filtering at the observed temperature and pressure rendered some ingenious devices necessary, and the pressures were read both on Bourdon gauge and on an open mercury column.

Without going into the interesting details of the observations, the general results may be given, as having an important bearing upon the purification of boiler feed water. In a general way the popular idea as to the diminished solubility with increased temperature was borne out, but experiments with temperatures up to 200° C. showed that entire solubility was not reached.

Starting at 100° C. the solubility was 1.945 grammes per litre, while at 200° C. the quantity dissolved was still 0.155 grammes of sulphite of lime per litre. As above indicated, however, it was found that the solubility for any temperature diminished with the lapse of time, or in other words, that time was required to effect precipitation. Thus while the solubility at 100° C. is 1.945 gr. per litre at first, it falls to 1.648 gr. after the lapse of 8 hours; a reduction of about 15 per cent., and a similar effect is produced at other temperatures. Plotting the results in the form of a curve, it appears that the rate of precipitation is somewhat more rapid at high temperatures than at lower, but in every case several hours are required to attain the stationary solubility for a given temperature.

Although M. Boyer-Guillon gives only his methods and results, some immediate practical conclusions may be drawn from them. It is often attempted to purify feed water by heating it in a separate vessel before passing it to the boiler. The temperature of exhaust steam is generally deemed sufficient to cause the precipitation of the carbonates of lime and magnesia, but higher temperatures, generally attained by the use of live steam, are found necessary for the more or less complete removal of sulphates. In view of the above investigations it is evident that most of the sulphate of lime will be carried forward into the boiler with the feed water unless sufficient time be given for it to separate. In proportioning such heaters and purifiers, therefore, it is important to compute not only the heating surface necessary for the transfer of the heat to the water, but also to make the capacity sufficiently great to allow the water to remain in the heater long enough for the precipitation to be completed. In any case this method of purification is shown to be only partially effective, and in the light of M. Boyer-Guillon's admirable researches previous opinions must be modified.

The Performance of Grinding Machines.

UNTIL a comparatively recent date there has been little definite information available as to the performance of various kinds of machine work, the proportions of tools being based mainly upon experience and imitation. The actual stresses and strains are even yet imperfectly known, and the relative values of different methods of removing material are often matters of individual opinion.

With improved appliances, however, it is possible to measure the effort exerted and compare it with the result obtained, in such a manner as to enable some measure of the true efficiency to be obtained for future similar cases.

This question forms the subject of an experimental study by M. Codron, of which the first portion is published in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale,* of which some points may be here reviewed.

Mechanical operations may be classified into Forging, including all methods of working which change the shape without removing any material, and Fitting by which definite dimensions are given by removing a portion of the material. M. Codron confines himself to an examination of the latter class, and, in the portion of his investigations at present under examination, discusses only operations of grinding, leaving the work of cutting and shearing tools for subsequent investigation.

The elements which characterize an operation are often very variable, and hence it is only possible to examine the general conditions, furnishing data and methods upon which special studies may be based.

Considering rotating grinding wheels, in which the piece to be worked is pressed against the periphery of the wheel, the result depends upon the velocity of rotation and the pressure upon the work, also upon the hardness and size of grain of the grinding material. While these conditions cannot be altogether reduced to mathematical expressions, yet it is possible to so arrange them as to render them in some degree comparable. The mechanical elements are very simple, consisting of the radial pressure of the work upon the wheel, determining the penetration of the grains of grinding material into the metal, and the tangential velocity of the grinding surface. The ratio of the pressure of the work and the tangential effort is called by M. Codron the "coefficient of attack," and may be used to compare the relative cutting power of various wheels. By combining this expression with the rotative velocity of the wheel, and with the density of the metal worked, a formula is deduced by which the quantity of metal removed for a given expenditure of mechanical energy may be computed.

Having thus stated in mathematical form the relations of the various elements under consideration, experiments were conducted in order to enable the coefficients to be determined for different operations and materials. The important question of the quality of the wheel employed as a grinding material was readily determined by changing wheels and maintaining all other conditions constant. The quantity of metal removed in a given time then became a measure of the quality of the wheel. Thus with a wheel of very good quality 110 grammes of metal were removed under certain conditions in 15 minutes, while a medium grade wheel, under the same conditions removed 55 grammes, and a poor wheel only a little more than 6 grammes! In like manner the relative quantity of metal removed for different materials, using the same wheel and the same operative conditions, enables comparisons to be made determining the relative adaptability of grinding operations for the respective metals. Another comparison of the behavior of various grades of emery wheels is found in comparing the weight of metal removed with that of wheel abraded. Judged in this manner the best wheel above noted removed 8 kilogrammes of metal in producing 1 kilogramme of dust, while the corresponding result for the medium wheel was 3.448 kilogrammes, and for the poor wheel only 1.625 kilogrammes.

M. Codron describes in detail the combinations of registering dynamometers and spring balances by which the data were determined in the various trials, and gives tabulated statements of the results which show clearly the value of such experiments. When the tabulated data are plotted in the form of curves, it is possible to see very clearly the influence which the various conditions exert, and some interesting conclusions may be drawn. In order to remove one gramme of wrought iron about 500 kilogrammetres of energy were required, or 500,000 kilogrammetres per kilogramme (about 1,640,000 foot pounds per pound), this being explained by the minuteness of the particles removed. These figures give some idea of the magnitude of the energy stored in the cohesion of the particles of iron. Comparing the energy recorded by the dynamometer with that actually utilised, it appears that the mechanical efficiency of a grinding wheel is good, attaining about 83 per cent., the losses being mainly in journal friction, some portion being doubtless also in the dynamometer.

An examination of the curves shows that the maximum efficiency is not obtained with the maximum pressure upon the work, but that there are relations between speed and pressure which give the best results, and which should therefore be observed in design. Reproductions of the diagrams of the recording dynamometer are given, which show in a most interesting manner the variations in action for different speeds and materials, and the whole forming a most valuable contribution to the data of machine design.

Subsequent papers will deal with the action of other forms of machine tools.

Clearance and Compression in Steam Engines.

At various times during the past three years, or in fact ever since the first announcement by Professor Dwelshauvers-Dery of the unexpected results of his experimental study of the effect of compression upon steam consumption, notice has been taken in these columns of the study which others have given to this important subject. The latest of these papers is one by Herr H. Dubbel in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure,* giving a review of all the important research work which has been done in Europe and America in connection with clearance and compression, drawing practical conclusions from the combined results.

Briefly, the original statement of Zeuner was to the effect that the injurious effect of clearance could be entirely overcome by compressing the exhaust up to initial pressure, the clearance space being thus filled with compressed exhaust steam at initial pressure before live steam was admitted. The experiments of Dwelshauvers-Dery upon the experimental engine at the University of Liége showed, on the contrary, marked losses with increased clearance and corresponding compression, which he sought to explain by the action of cylinder condensation upon the compressed steam. This position was contested by several well-known engineers, notably by Professor Boulvin, of the University of Ghent, who applied the temperature-entropy diagram to the published data, and showed that the heat exchanges did not correspond to the theoretical conclusions. A discussion by former Engineer-in-Chief B. F. Isherwood, U. S. N., also reviewed in these columns in April, 1900, while accepting the results of Professor Dwelshauvers' tests, advanced the theory that the losses were due, not to increased cylinder condensation, but to the increase in negative work due to compression.

Experiments by Doerfel upon a Corliss engine at the Radotin cement works, using widely varying degrees of compression, showed that the loss due to initial condensation was diminished by increased compression. Herr Dubbel gives a tabular abstract of the now famous experiments by Professor Dwelshauvers, and then follows these with the data and results of the experiments of Professors Barr and Carpenter at Cornell University, and of Professor Jacobus at the Stevens Institute of Technology. These latter two series of experiments, very carefully conducted by American engineers of wide reputation for accuracy and skill, show that for degrees of compression ranging from 11 to 35 per cent., bringing the compressed exhaust steam from ⅝ up to full initial pressure, the steam consumption per horse power was not materially altered.

Weighing all the conditions carefully, Herr Dubbel concludes that the experiments of Doerfel, Barr, Carpenter, and Jacobus are entitled to acceptance, and that there is little or no loss in steam consumption with increasing compression. The results obtained by Professor Dwelshauvers he can only explain as due to leaky valves and piston.

REVIEW OF THE AMERICAN PRESS

The Coaling of Warships.

THE question of coal is such an important one in connection with the efficient performance of warships that much attention has been given to it both by naval and civilian engineers, and many appliances have been devised to be used in the operation of coaling. A very full discussion of the whole subject appears in a paper before the American Society of Naval Engineers, by Lieut. Commander J. R. Edwards, U. S. N., and published in the *Journal* of the Society, from which the following abstracts are made. Nearly all the improvements which have been made in coaling appliances are intended to increase the speed of the operation, and as the speed with which coal can be delivered is limited by the facility with which it can be stowed, Mr. Edwards very properly makes some pertinent recommendations as to the best arrangements on shipboard.

The great difficulty is at the bunkers, where delays are sure to cause blockades, and Mr. Edwards examines at length the changes which he thinks advisable to enable vessels to receive and stow coal as rapidly as modern appliances are able to deliver it.

Vertical chutes are recommended in all cases, as inclined chutes clog very easily, bituminous coal readily choking at an angle of 45 degrees. An insufficient number of openings is also a cause of delay in coaling, and transverse bunkers, when possible, will also be desirable, although the latter are only practicable in a limited number of instances. A graphic account of the difficulties and hardships of coal trimming emphasises the plea made by Mr. Edwards for more openings and fewer bunkers.

The question of the actual handling of the coal is fully considered, whether from land, from barges, or from colliers at sea. Mr. Edwards advocates very strongly the importance of keeping reserve coal afloat. The number of handlings of the coal is thereby reduced, while at the same time the strategic advantages due to the possibility of quickly distributing to various ships are secured. It is very well put that if the United States government has been willing to pay $50,000 bonus for each quarter knot in speed above contract requirement, a corresponding saving in time in other lines should be equally valuable.

In regard to the use of patent transporters for ordinary coaling, Mr. Edwards is of opinion that there are many such which can be produced of various machinery supply houses, and that there is no necessity for tying up to some particular device for all places. Some pertinent remarks are made in regard to the important subject of the location of coaling stations. The risk of a supply of coal being "bottled up" so to speak should not be possible. The ports frequented by commerce naturally possess many advantages, but the possibility of their being closed in time of war must not be overlooked.

In time of war coaling stations should be near the base of operations, wherever possible. With this comes the question of the possibility of coaling at sea. Among the devices which have been made for this service various forms of barges equipped with conveying and handling devices are discussed, but these involve the close approach to the warship, a matter which is often impracticable.

A far more practical device is the Miller marine cableway, in which the collier is towed at a moderate speed by the warship, while the coal bags are delivered by a cableway over the intervening distance. The chief difficulty in this device, that of overcoming the variations in tension due to the pitching and rolling of the vessels, has been very successfully handled by Mr. Miller, and a very complete account of the trials with the collier Marcellus and battleship Massachusetts will be found in the issue of THE ENGINEERING MAGAZINE for February,

1900. The Miller cableway is to be given an exhaustive series of trials in the British navy, which will probably decide the question of its adoption there.

"This coaling question grows in importance as the subject is carefully considered. It concerns the Navy too much to be ignored, and therefore the sooner the question is met the better it will be for the interests of the service. The fact must be apparent that we are weak in coaling facilities on many vessels. If necessary, therefore, large expenditures should be authorized to make desirable changes. This may be a troublesome question, and yet as one beholds the great strength of the British navy and studies its past history, he is impressed with the fact that one of the causes which has produced its predominance has been the moral courage of its administrators in meeting rather than avoiding troublesome questions.

"In the solution of this coaling question, primary consideration must be given to the location, size and character of the bunkers, and it should be realized that getting a sufficient supply to the fire room is only a little less important than getting the coal into the bunkers.

"In the consideration of this question, the greater tendency has been to provide for the reception of coal on the deck of the warship. There has been neither too much time nor money expended in improving matters there, and it is even regrettable that increased opportunities to improve matters in this respect have not been given our commanding officers. It is more important still, however, that changes be made in the warship itself. If for a time improvements in the bunker arrangements can be considered as the most important phase of this question, then we shall meet with a degree of success in coaling ship that will make the evolution less unpleasant and much more satisfactory. And while effecting improvements on board the warship, we should look to the question of securing colliers and barges that would answer our requirements.

"This subject will only be accorded the consideration that it merits, when a board of officers of high rank shall carefully consider the matter in all its bearings. There is not a bureau chief at the Navy Department whose time is not already taken up, and therefore, this work should be carried on by a special board presided over by some senior officer who has commanded warships of various descriptions, and who by experience knows of the discomfort, difficulties and demoralization attending the coaling of warships.

"However distinguished, able and competent an individual may be to give expression of opinion upon technical matters, it is a fact that individual views and recommendations never carry the weight that goes with the deliberate report submitted by a board of experts. The report of a board implies a consensus of views, of at least a majority of the members, and such a conclusion is founded after free discussion which is sure to have shown up the various phases of the matter.

"If the report of a board is often a compromise, it generally commands increased support for that reason. It certainly obliterates all the extreme views and prejudices of the individual. One has only to recall to mind the work of the several Advisory Boards, the Ordnance Board, the Armor Plate Board and the present Construction Board to note the thoroughness with which such boards have entered upon their duties. And with this experience it can be confidently expected that an inestimable benefit would accrue to the Navy from the deliberations and conclusions of some future Coaling Board."

Modern Appliances in Railway Construction.

In a recent paper on heavy railway construction in Wyoming, presented before the American Society of Civil Engineers, and published in the *Proceedings* of the Society, Mr. J. I. Boggs gives an interesting account of some important work on the line of the Union Pacific Railroad. It is not the present object to go into details of this work at the present time, but rather to comment upon the large amount of construction work which can be done with modern power machines, especially in localities where skilled labor is scarce and expensive, and where time is limited.

The particular work under consideration was the running of a new connection in order to lower the elevation of the highest summit on the road, this including a tunnel of 1,800 feet in length and some very heavy grading, the total being 1,254,548 cubic yards, of which there was 312,257 cubic yards of solid granite excavation.

At the altitude of the work, about 8,000 feet above sea level, the season is very short, the snow ending only at the beginning of June and returning in September. It was therefore found necessary to work night and day, and an electric light plant was one of the first portions of equipment constructed. With this was also a compressed-air plant, and much piping and wiring for both.

On the section particularly discussed by Mr. Boggs, this being about four miles long, there were in operation eight steam shovels, and fifteen locomotives, with trains of 10 to 18 cars each, and many rock drills and other machinery.

As a specimen of the rapid manner in which heavy work was accomplished, the Dale Creek fill may be mentioned, this involving the filling of 475,000 cubic yards of earth, and being completed between June 8 and December 1. Other rapid pieces of heavy work which may be noted were an embankment 900 feet long, containing 110,000 cubic yards, executed between May 24 and October 20; also a 60,000 yard excavation, of which 86 per cent. was solid rock, completed between June 16 and December 31.

While there was probably nothing very extraordinary about the work, it does show the wonderfully short time in which an immense amount of work in railway grading can be accomplished with modern appliances and methods under difficult and discouraging conditions. The difficulties were increased by reason of the worthless and thriftless class of men which constituted a large proportion of the labor available. The wages paid were $2.25 per day to muckers and drill helpers, and $3.50 per day to drillers, the foremen receiving $125 per month.

The Development of the Rotary Transformer.

The advantages of alternating currents so far as conditions of economical transmission are concerned are generally conceded, but for a great variety of uses the continuous current is preferable. At the same time a change of pressure is in most cases desirable, and hence the transformer by which these changes are accomplished is a very important piece of electrical apparatus.

The whole subject of rotary transformers, including their history, theory, and characteristics, forms the subject of a paper by George W. Colles, this paper forming a thesis presented at the Columbian University, and published in the *Journal of the Franklin Institute*.

The various kinds of transformations are classified into four groups according as the transformation is effected in respect of pressure, in respect of kind, in respect of frequency, and in respect of phase relations, there being varieties under these according to the nature of the currents.

Mr. Colles gives in his paper numerous illustrations, mainly taken from original patents, and treats exhaustively of the various types, but we have only space here for his analysis of the five principal types, leaving the reader to the original paper for further details.

The first, or rectifier type, is far the most ancient, dating back, according to Thompson, as far as 1838, and being in common use in 1869, when they were used for the field magnets of self-exciting alternators. This apparatus can hardly be called a transformer in the proper sense, as it contains no inductive or other coils, being nothing more than a rotating commutator, whereby the pulsations of the alternating or polyphase current are commuted and rendered unidirectional, or, on the other hand, the direction of a continuous current is periodically reversed. In the former case the rectifier must be rotated synchronously by a donkey motor. A commutator of this sort is easily devised, and a number have been put on the market; but the device is crude and at best a makeshift, as no truly constant current can be produced, especially from a simple alternating current; on the other hand, a true alternating current is not produced by reversing the poles of a continuous current circuit. The main defect of this class of devices is, however, the common one of excessive sparking, owing to the fact that the circuit must be periodically broken at each reversal to avoid the alternative of short-circuiting the primary mains. The best known of these devices is perhaps the Pollak rectifier, which takes the current only from the tops of the waves of electromotive force, and so insures greater uniformity, though at the expense of continuity. This machine has been used in the Ferranti station at London to charge a battery circuit.

The inductorium type is characterized by a series of induction coils, which may or may not be stationary, arranged in a circle and having their primary and secondary coils, one or both, connected to the respective segments of a commutator; the apparatus is not, in general, self-rotative or self-regulating, as in our common motor-transformer, but must be rotated by a donkey-motor or other external source of power. One or two commutators are used, according as a direct and alternating or two direct currents are wanted. In this class there are three well-marked subclasses:

(1) The stationary independent coil type, in which each induction coil is wound upon a separate core, and separately connected to the commutator or commutators through slip-rings. This, the oldest of transforming devices for direct currents (if we except the rectifier), has proved, in the hands of two ingenious French inventors, one of the best, if the fatal defect of sparking can be overcome.

(2) The stationary ring type, in which the separate induction coils are now wound together all upon one ring, which has two independent sets of coils wound thereon Gramme fashion, and connected to the commutator or commutators through slip-rings.

(3) The rotating ring type, identical with the former, except that to avoid the slip-ring connection and possibly to give stability to the rotation, the induction ring is mounted on the commutator-shaft. The "dynamotor" has not been reached, as no external fields are provided.

In the motor generator type is included the very simple device of an independent generator coupled to a motor on the same shaft, or otherwise mechanically connected to it. Starting thus from an entirely different basis from either of the preceding, the two following types have been successively evolved.

In the dynamotor type the two independent machines of the preceding type are merged into one—usually a single armature, sometimes two armatures, but always in one field, and always with independent primary and secondary coils; its use being practically confined to continuous currents only, with a commutator for each coil.

Proceeding still one step further in the same lines, we reach the true rotary transformer; in which we have one machine, one armature and one coil only in that armature—in short, a dynamo of the ordinary drum or ring-wound type, but provided with two sets of connections to its armature coil, one of which *must* be a set of slip-rings for an alternating or polyphase current.

It should here be noted, that we have not taken the steps leading from the motor-generator to the rotary transformer type without serious sacrifices; for the first was at the expense of regulation, the second at the expense of a pressure transformation. So doubtful is the balance of advantage in favor of the rotary transformer, in fact, that even to-day the motor-generator is preferred in many cases, and it has not infrequently happened that, proving unsatisfactory, transformers have been taken out and replaced by the old motor-generator type.

American Slag Cements.

THERE has been so much said pro and con about the merits and disadvantages of cements made from furnace slag, that the paper by Professor W. K. Hatt, presented before the Indiana Engineering Society, containing data and results of many tests of such cements, may well be welcomed. Since a portion of the controversy has been as to the definition of a "Portland" cement, Professor Hatt's definitions may be here repeated. The crucial distinction appears to be in the calcination of the product to a clinker. When the cement is made by calcining a mixture of slag, sand, and limestone it may properly be called a Portland cement. A slag cement is a cement made by grinding a mixture of pulverized granulated slag and slake lime, this mixture having been made without applied heat.

The paper contains tables giving the chemical composition of the cements tested, together with data and results of the tests, these results being also graphically plotted. So far as tension and compression tests are concerned, the mechanical strength appears very favorable, although not all are equal to the best Portland cements.

One of the best American slag cements, at the end of a year, gave a strength of above 550 pounds per square inch. The results given in the present tests at the end of 90 days are 507 ℔., 483 ℔., and 217 ℔., respectively for neat cement, 1 to 1 of sand, and 1 to 3 of sand.

The appearance of slag cement is characterized by a delicate lilac color, in some cases almost white. When cement is made from slag by a process involving roasting, the cement is of a dark color like that of ordinary dark colored Portland cement. It has not the coarse or gritty feeling which characterizes most Portland cement. It works fat, sets slowly and passes ordinary tests for permanence of volume.

A pat of slag cement exposed to the air has to be well covered to prevent the surface from cracking. After drying out it will exhibit discolorations (yellowish or brown), whereas the pat hardened under water will not exhibit such discolorations. The characteristic color of the fracture of a water hardened briquette is green, but when the briquette dries out the fracture becomes white. The writer has noticed this green color, with a subsequent change to white, in the case of a well-known American Portland cement, and also the discoloration in the pat. This indicates slag adulteration, or else that there was not a sufficiently oxidizing flame in the kiln. The green color is due to the presence in slag cements of a percentage of sulphide of iron, or sulphide of calcium. This sulphide becomes oxidized on exposure to the air and changes color. Slag cements usually contain from 0.5 to 1.5 per cent. of sulphides.

It is this tendency to oxidation on exposure to the air which is destructive to mortar made of slag cements containing sulphides, and makes it necessary to use the product in underground situations or the interior of thick walls. A parallel test of briquettes hardened in air and water should be made to check up the presence of sulphides. This disintegration does not occur in case of all slag cements, and it is not a necessary defect.

The European slag cements which set finally in 6 or 8 hours seem to be more slowly setting than the American cements, which take their final set under the 1-℔. needle, in from two to three hours.

In the case of Portland cements, quicklime exists after burning and grinding, and air slaking or ageing is required. Often these Portland cements are sent out too new, the lime being masked temporarily by sulphate of lime. Since in the case of slag cements the lime is completely hydrated, no such danger exists of blowing or swelling; and they are said not to need any ageing. They are also said not to deteriorate on storage.

The presence of a considerable amount of metallic iron in slag cements serves at times as a means of detecting the adulteration of Portland cement with slag. If a magnet is passed several times through these cements, a considerable amount of this metallic iron will cling to the magnet. This amount, however, is variable, sometimes amounting to 0.33 per cent. and at other times only 0.1 per cent.

One element of value in the slag cement is that owing to its light color it is said not to stain masonry. This statement has been contradicted. Its specific gravity is considerably less than that of Portland cements; it ranges near 2.8, whereas Portland cements range near 3.10.

Water Purification in Washington.

Many large cities are now becoming aroused to the fact that pure water supply must nearly always be secured by purifying the water, and not by expecting to secure and maintain an originally pure supply. The principal question to be considered is the proper method of purification.

In many cases there is a contest between the so-called "mechanical" system and the slow sand filtration systems of purification, and the decision is often based upon local considerations. Recently the city of Washington has had under consideration the purification of its supply of water, and as has already been remarked, the respective merits of the mechanical and the slow sand systems came up for consideration. The mechanical system, using a coagulant and then filtering under pressure, was advocated by Lieut. Col. Miller, U. S. A., to whom the matter had been referred by General Wilson, while the Medical Society of the District of Columbia, in the report of a committee presented to the U. S. Senate, came out strongly for slow sand filtration.

The matter was finally referred to three well-known experts in the matter of water purification, Messrs. Rudolph Hering, George W. Fuller, and Allen Hazen, and their report, published in a recent issue of the *Engineering Record,* contains some interesting matter in respect to the proper use of the two methods.

It is a mistake to assume that either method is in itself appropriate, and the importance of ascertaining the conditions in each case is emphasized.

The character of the raw water is often an element of controlling importance in deciding a question of this kind. Generally speaking, sand filters are best adapted to purifying waters that are not extremely turbid, and mechanical filters have marked advantages in the purification and clarification of waters which for considerable periods are very turbid.

Viewed in this respect, the water of the Potomac is especially to be considered. Its average annual turbidity is about 80 parts of suspended matter in the million, which permits successful sand filtration, while after heavy rains the water becomes more turbid than any which has been successfully purified by slow sand filters in America. Although the turbidity could be materially reduced by subsidence there are times when it would not be possible to afford adequate preparatory treatment by this method, it being estimated that such periods might amount to one month in each year. The result of these investigations was a recommendation of the establishment of a complete system of slow sand filtration, with the auxiliary works which may be necessary for preliminary sedimentation, and with arrangements for the use of a coagulant for a part of the time. This, as it will be seen, is something of a compromise between the two systems under discussion, and as the raw water varies at different parts of the year to conform to the applicability of the two methods, this conclusion appears most reasonable.

An interesting portion of the report, and one upon which possibly more might appropriately have been said, was that relating to the waste of water. This matter of waste is so closely bound up with that of purification that it appears in nearly every case where filtration is under consideration, and where the large volumes of water to be treated form such an important element.

In the case of Washington the experts say:

"In this connection we beg to call attention to the large waste of water in Washington, and to suggest the advisability of taking measures to limit such waste. One of the most effective means of doing this is by the use of meters; and we recommend that they be placed on all public buildings at once, and on private services, when deemed necessary, as rapidly as practicable."

A general popular objection to the introduction of water meters is the fear that public health will suffer because of the efforts of the poorer residents, from motives of economy, to stint themselves in the use of water. While this argument is readily met by the adoption of a reasonable minimum charge, below which no reduction in payment could be obtained, there is another point to be considered, namely, that the public health is far more likely to be affected by the use of impure water made necessary because of the impossibility of purifying the immense quantity demanded and wasted. The supply considered by the experts in the case of Washington was 75,000,000 gallons per day, a quantity which, as they say, is sufficient to supply all legitimate needs of a population much greater than the present one.

With the introduction of meters such a supply would be ample for a long time to come; without them doubtless additional supplies and additional purifying plants will be demanded before long.

The Fortification of the Isthmian Canal.

The question of the neutrality or otherwise of any canal which may be cut to unite the Atlantic and Pacific oceans was discussed in an address recently delivered before the American Academy of Political and Social Science, by Col. Peter C. Hains, U. S. A., and some of his more important conclusions may be noted here. It will be remembered that Col. Hains was a member of the Isthmian Canal Commission, and is therefore in a position to speak with especial information upon the subject.

So far as the nature of any fortifications are concerned, Col. Hains disposes at once of the idea that any land fortifications along the line of the waterway could be of any importance. The real control of the canal would lie in the waters about the entrances. The nation that controls the adjoining seas will, in time of war, control passage through the canal, no matter which one has possession.

While a canal cannot be satisfactorily defended along its line, it is peculiarly susceptible to damage. A few resolute men could disable it with little danger to themselves. This danger of being temporarily disabled is a serious one even in a war with a weak naval power. The destruction of a lock or embankment, which could be accomplished with a few pounds of dynamite, would bring about a total suspension of navigation for an indefinite period.

Considering the actual military value of the canal itself, Col. Hains shows that it must be considered valuable only as a shortened line of communication. It would be of no use as a base of communication, and would not be able to compete with railways as a route for transportation of munitions of war and troops. Its value would be for the conveying of ships from one coast to the other, and for such purpose it should always be open. As a line of communication it would be badly located when considered in a war with a superior naval power, for instead of being in a protected position behind the main line of defence, it would be out beyond the main skirmish line.

The real function of the canal, in the opinion of Col. Hains, would be fulfilled by making the waterway neutral. It could not then become a prize of war, nor would an army be needed to protect it, nor a fleet necessary to maintain open communication through it. It has been said that the neutrality of the canal would permit Great Britain to send ships through it in event of a war with the United States, but even that is doubtful. Some time might be gained to a British fleet by such action, but the risk in so doing would hardly render it justifiable.

According to Col. Hains, the most desirable end to be attained would be an arrangement by which the regions of the canal and large areas of the sea at each terminus should be exempted from the operations of war. The larger the areas of neutrality the better, and Col. Hains himself suggests arcs of circles of one hundred miles radius as boundaries. Should a foreign power attempt to violate the neutrality, the United States could destroy the canal, and thus would hold command over the situation in any event. As Great Britain and the United States together would be most deeply interested in the use of the canal, it seems as if they should be able together to cause some such agreement to be adopted. In concluding, Col. Hains expressed himself as of the belief that in the existing status of the naval powers of the world, a neutral canal would be more useful to the United States from a military standpoint, than one controlled by a military power.

Hydraulic Excavation.

HYDRAULIC mining is a term that nearly every one who has heard of gold mining in California knows, but the tremendous power of jets of water under pressure to disintegrate earth, gravel and rock can only be fully appreciated by those who have seen the transformation which the operation has made.

A paper recently presented before the Engineer's Club of Cincinnati by Mr. Latham Anderson, and published in the *Journal of the Association of Engineering Societies,* gives some interesting data concerning the history and growth of hydraulic excavation, and although the process is now forbidden for mining purposes, he suggests that its capabilities for moving earth for engineering purposes have not as yet been fully appreciated. In mining, the jet of water is used to break down solid banks of earth in order that the gravel may be disintegrated in form for washing out the gold, and the result has been to demonstrate the manner in which the method may be used to move the material under favorable conditions.

Two examples of the action of hydraulic mining in California are given to show the capabilities of the process, viz., the North Bloomfield, in Nevada county Cal., and the Spring Valley, at Cherokee, Butte county. The capital invested in the North Bloomfield was $2,500,000. To gain outlet for the tailings into the nearest canyon, a tunnel 7 by 9 feet, 6,900 feet long, had to be cut through solid rock. The sluice line was over 2 miles in length and 6 feet wide. The "bank" or auriferous gravel deposit was 400 feet deep and 600 feet wide, the company owning a mile and a half in length of this deposit. A 6-inch giant was used under a 500-foot head delivering 32.8 second feet of water and developing nearly 1,690 horse-power; and a 7-inch nozzle under a 250-foot head, delivering 31.54 second feet and developing about 1,560 horse-power. From 15,000 to 18,000 cubic yards of gravel were washed away each day of twenty-four hours.

The Spring Valley bank was about 400 feet in height. The bed rock tunnel was much shorter, but to obtain a dumping ground the company had to purchase over 700 acres of valuable farm land. At the time of the writer's visit in 1882, they had buried this land 12 feet deep with tailings, were expecting to add three feet to this depth, and still would be under the necessity of buying more land.

In the case of an engineering plant the moving of the earth is the main and only object, and hence the loosening and delivery of the material only demands attention, and much of the carefully constructed work of the gold mining hydraulic plant is not needed.

It is a mistake to estimate the cost of a hydraulic excavating equipment for engineering purposes from data taken from mining practice, since in the latter case the main object is to secure the gold, the movement of the earth being a means to that end. At the same time such engineering plants as have been constructed for hydraulic work are usually inferior to the great hydraulic mining plants in the following particulars:

First. In volume of water.

Second. (Usually) in amount of head or pressure.

Third. (Probably in most localities) in not having a natural or gravity supply and pressure.

But, on the other hand, we have the following advantages over any and every mining plant:

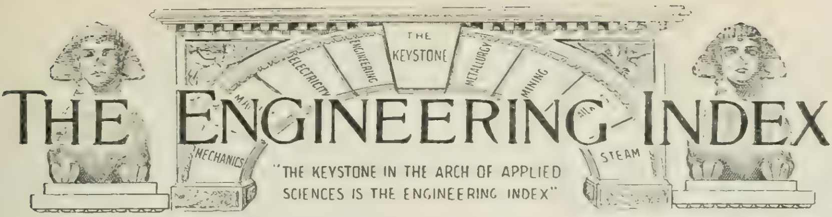
First. We may use cheaper boxes and sluice line.

Second. We avoid the expense of all the costly gold-saving devices and appliances—*e. g.*, costly bottom paving in the sluice line, undercurrents, box-riffles, retort house and the loss of at least four days' time each month in "cleaning up" (collecting amalgam) and in repairing sluice line.

Third. We save the interest and sinking fund on the capital invested in the huge dam and reservoir, and in the scores of miles of main ditch.

Fourth. The outlay, in railroad work especially, will be much smaller for giants, pipe line, tools and machinery for the cut than in mining.

Mr. Anderson gives data of a number of instances in which hydraulic excavation has been successfully employed in dam construction, filling, excavating, etc., and emphasizes the great economy attending its use.



THE ENGINEERING INDEX

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. w. Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago,
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly, New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U. S. A
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Bascule Bridge.

Bascule Bridge Over the Chicago River at Clybourn Place, Chicago. An illustrated description of a bridge that is a type of several to be built in Chicago and vicinity. 5500 w. Eng News—Jan. 31, 1901. No. 39092.

Boston, U. S. A.

The Charlestown Bridge, Boston. Illustrated description of a bridge for carriages, street railways, and a double-track elevated railway, having plate-girder approach spans and a 1,200-ton swing span 240½ ft. long and 100 ft. wide. The unusual swinging, braking and latching appliances are fully described. 2000 w. Eng Rec—Feb. 9, 1901. No. 39232.

Bridge-Building.

Bridge-Building — Past and Present. Editorial on the development, noting progressive types and structures of interest. 2000 w. Engng—Jan. 25, 1901. No. 39164 A.

Concrete.

Low-Level Concrete Bridge Over the Mary River, Maryborough, Queensland. Alfred Barton Brady. Abstract of a paper read before the Inst. of Civ. Engs. of Gt. Britain. Illustrated detailed description of the bridge and method of construction. 3500 w. Eng News—Feb. 14, 1901. No. 39261.

The Concrete Bridge at Goat Island. Illustrated description of a concrete-steel bridge with spans from 50 to 110 ft. long, a stress diagram of the largest being given. The construction of the bridge was extremely difficult, owing to the current. 3000 w. Eng Rec—Feb. 16,1901. No. 39314.

Drawbridge.

The New Middletown Drawbridge. H. G. Tyrrell. Illustrates and describes a highway bridge in Conn., 1,300 ft. long, with a 26 ft. roadway, and provision for two 6 ft. sidewalks. Beside the street traffic it carries an electric railway line. 1600 w. Elec Wld & Engr—Feb. 16, 1901. No. 39323.

Erection.

A Novel Method of Bridge Erection Without Falsework. Extract from a recent paper before the Inst. of Civ. Engs., by C. F. V. Jackson, describing the design and construction of a railway bridge in Queensland, Australia, presenting a novel plan for dispensing with falsework. 1000 w. Eng News—Feb. 21, 1901. No. 39385.

European Bridges.

The Aesthetic Characteristics of European Bridges. Editorial, with the first of a series of views of notable bridges, selected by E. M. Wheelwright, who has made a study of this subject. 350 w. Eng Rec—Feb. 2, 1901. No. 39129.

Failures.

Failures of Bridges and Bridge Members. A discussion of the causes of failure of highway bridges and exceptional instances of strength of pin-connected structures. With illustrated letter describing failure of bridge at San Mateo under a drove of horses. 1500 w. Eng Rec—Feb. 16, 1901. No. 39313.

Plate-Girder.

A 103-Ton Plate Girder. Illustrated description of a four-track plate-girder bridge, 111 ft. long and 12 ft. high, having unusual rocker bearings, web reinforcement and floor details. 1000 w. Eng Rec —Feb. 2, 1901. No. 39132.

Rail Bearers.

Strength of Rail Bearers. Editorial discussion of past and present practice, calling attention to cases of interest. 1800 w. Engr, Lond—Feb. 8, 1901. No. 39371 A.

Strengthening.

Strengthening Bridges on the Gothard Railway (Einige Brückenverstärkungen der Gotthardbahn). Emilio Lubini. Giving illustrations and computations of the methods by which a number of lattice girder bridges on the Gothard railway have been reinforced. Two articles, 3800 w. Schweizerische Bauzeitung—Jan. 19, 26, 1901. No. 39451 each B.

Superintendence.

The Superintendent of Bridges and Buildings—His Duties and Responsibilities. Onward Bates. An address before the St. Louis Convention. 3500 w. Pro of Assn of Ry Supts of Bdgs & Bldgs—Oct., 1900. No. 39160 D.

Suspension.

A Novel Suspension Bridge. M. S. Parker. Illustrated description of a contractor's bridge consisting of wire cables drawn taut and covered with a light frame track, for use in filling a ravine. 500 w. Eng Rec—Feb. 2, 1901. No. 39131.

CANALS, RIVERS AND HARBORS.

Barge Lift.

Barge Lift at Foxton, Leicestershire. Illustrated description, with statement of the advantages of the lift over locking.

600 w. Engng—Jan. 25, 1901. No. 39163 A.

Canals.

American Isthmian Canals. I. The Topography and Hydrography of the Isthmian Region is discussed by James Christie. II. The Engineering Features of the Nicaragua Route, by Edwin F. Smith. III. The Panama Route, by Louis Y. Schermerhorn. Maps. 7500 w. Pro Engs' Club of Phila—Feb., 1901. No. 39238 D.

Method of Cementing the Irrigation Canals of the North Riverside and Jarupa Canal Co. E. Duryee. Brief illustrated description of the method adopted in plastering with cement the canals named. 600 w. Eng News—Feb. 21, 1901. No. 39386.

Shall a Canal Be Built From the Lakes to the Sea? William G. Raymond. An argument against the construction, urging that the enterprise is unnecessary and unjustifiable. 2000 w. R R Gaz—Feb. 15, 1901. No. 39298.

The Canals of Canada. Waldon Fawcett. Information of interest concerning the Welland and the St. Lawrence Canals. Ill. 1800 w. Sci Am—Feb. 9, 1901. No. 39210.

The Hennepin, or the Illinois and Mississippi Canal. Henry Fox. An illustrated description of the construction work, with an account of routes surveyed, the development of the country, and the reasons for the undertaking. 3200 w. Wis Engr—Jan., 1901. No. 39311 D.

The New Panama Canal Proposals. Discusses the reasons why the United States government favor the Nicaragua route, and the work being done by the new Panama Canal Co., and urges British interest in the Panama project. 3300 w. Engng—Feb. 1, 1901. No. 39285 A.

The Proposed Ship Canal to Connect the Great Lakes and the Atlantic Ocean. James H. Brace. Reviews the surveys made and reports of various routes. 5000 w. Wis Engr—Jan., 1901. No. 39309 D.

Canal Feeding.

The Pumping Plant for Feeding the Rhiner-Marne Canal (Pumpwerk zur Speisung des Rhein-Marne-Kanales). J. Hermanuez. Showing the arrangement of turbines and electrically-driven centrifugal pumps. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 2, 1901. No. 39435 D.

Canal Traction.

See Electrical Engineering, Power Applications.

China.

The Development of the Kiautschou District (Das Kiautschougebiet und seine Entwickelung). A description of the harbour of this German-Chinese treaty port. 5000 w. 1 plate. Glaser's Annalen—Feb. 1, 1901. No. 39441 D.

Docks.

Conneaut Harbor Ore Docks. Illustrated detailed description of this property and its management. 4500 w. R R Gaz—Feb. 22, 1901. No. 39501.

Dockyards.

Equipment and Methods of the Indian Dockyards. A. C. Bowden. Discussing especially the Bombay dockyard, and showing the successful operation of European methods in India. 3000 w. Engineering Magazine—March, 1901. No. 39471 B.

Dredges.

Sea-Going Hydraulic Dredges for the East Channel Improvement, New York Harbour. Brief illustrated description of two of the largest and most thoroughly equipped dredges ever constructed in America. 1400 w. Eng News—Feb. 14, 1901. No. 39258.

Puget Sound.

The Coming Industrial Empire of Puget Sound. D. B. Bogle. An examination of the great advantages of the harbours of the Northern Pacific coast of the United States, and the conditions which may insure their development. 5000 w. Engineering Magazine—March, 1901. No. 39470 B.

River Improvement.

Straightening the Mohawk River. Review of report by S. E. Babcock, who has recently surveyed this river and believes the improvement can be made. 3000 w. Fire & Water—Feb. 9, 1901. No. 39268.

CONSTRUCTION.

Carpentry.

The Music Hall of the Pan-American Exposition. Illustrated description of a structure 150 ft. square, with a main dome 130 ft. high. The wooden framing, fully described, has many unusual details of heavy carpentry. 2200 w. Eng Rec—Feb. 9, 1901. No. 39235.

Coffer-Dam.

The Accident to the Chambly Dam. Illustrated description of a coffer-dam constructed to permit the operation of a hydraulic power plant pending the replacement of a washed-out section of a masonry dam. 600 w. Eng Rec—Feb. 16, 1901. No. 39316.

Crystal Palace.

Engineering Details at the Crystal Palace. An illustrated description of work representing the practice of a generation ago by men of professional eminence. 3000 w. Engr, Lond—Feb. 1, 1901. Serial. 1st part. No. 39280 A.

Cupola Framing.

The Cupola of the Reichstag Building in Berlin (Die Kuppel des Reichtagshauses in Berlin). A. Zschetzsche. An exhaustive mathematical investigation of the stresses in the framework of the octagonal cupola upon the Reichstag building in Berlin. Three articles, 2 plates. 12000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 25, Feb. 1, 8, 1901. No. 39444 each B.

Foundations.

The Pneumatic Caisson Foundation for the Broad Exchange Building, New York City. A description of foundation work, interesting for its extent and the difficulties resulting from the short time available for carrying it out. Ill. 2800 w. Compressed Air—Feb., 1901. No. 39243.

Road Improvement.

The Cost of Wagon Transportation and of the Maintenance of Earth Roads. I. O. Baker. Abstracts of two papers presented at meeting of the Illinois Soc. of Engs. & Survs. Deals with actual conditions and prices. 3600 w. Eng News—Jan. 31, 1901. No. 39096.

Roads.

The New Road From Enzeli to Teheran. A description of a portion of an important enterprise carried out under Russian influence in Persia. Map. 3200 w. Engr, Lond—Feb. 1, 1901. Serial. 1st part. No. 39282 A.

Tunnelling.

Concrete Work on the East Boston Tunnel. An abridgment of parts of the report of Howard A. Carson. Describes the method of constructing a subaqueous tunnel of 23 ft. clear diameter with concrete walls. 2100 w. Eng Rec—Feb. 2, 1901. No. 39133.

Hydraulic Shield Tunnelling on the Melbourne and Metropolitan Sewerage System. A paper by George Henry Dunlop, read before the Victorian Inst. of Engs. Illustrates and describes work notably on account of the number of sewers of small diameter built in this way, the novel methods adopted for lining, and the variety and extent of the soft ground passed through. 8000 w. Eng News—Feb. 7, 1901. No. 39207.

Underpinning.

Underpinning High Masonry Structures. Illustrated description of the method of raising a large stone court-house, and of strengthening the foundations of an 80-ft. brick chimney. 1100 w. Eng Rec—Feb. 2, 1901. No. 39134.

MATERIALS.

Paving Brick.

Paving Brick Specifications and Tests. A report of the standard specifications adopted by the Illinois Society of Engineers and Surveyors, with a discussion of the reasons for their choice. 2000 w. Eng Rec—Feb. 9, 1901. No. 39234.

Requirements of Brick for Paving Purposes. H. E. Beasley. Read before the Illinois Clayworkers' Assn. Quotes from specifications for brick pavements to be used in Peoria, Ill., and discusses the value of the tests required. 1500 w. Brick—Feb. 1, 1901. No. 39176.

Preservative.

The Preservation of Structures in Metal, Wood, or Stone (Préservations des Constructions en Métal, Bois, au Pierre). L. Kirsch. A description of the protective coating devised by Zonca, of Venice, with accounts of tests. 3000 w. Rev Univ des Mines—Jan., 1901. No. 39418 F.

Timber.

Woods of the Philippines for Electrical Purposes. R. G. Mayse. Information concerning the large supply of wood suitable for telegraph and telephone service, and some of the native work. Ill. 1800 w. W Elect'n—Jan. 26, 1901. No. 39071.

MEASUREMENT.

Instruments.

Notes on Mine-Surveying Instruments, with Special Reference to Mr. Dunbar D. Scott's Paper on Their Evolution, and Its Discussion. Benjamin Smith Lyman. Ill. 17400 w. Trans Am Inst of Min Engs—Aug., 1900. No. 39230 D.

Remarks on Mine-Surveying Instruments, with Special Reference to Mr. Dunbar D. Scott's Paper on Their Evolution, and Its Discussion. H. D. Hoskold. Ill. 7600 w. Trans Am Inst of Min Engs—Aug., 1900. No. 39223 D.

Surveying.

Controlling a Topographical Survey. William C. Bunnel. A discussion of methods, describing in detail the method recommended and illustrating by an actual case. 3000 w. Eng News—Feb. 14, 1901. No. 39256.

Stadia Surveys for Railway Location. H. P. Boardman. On the advantages of the Stadia method as applied to railway location, and its economy. 2700 w. Eng News—Feb. 21, 1901. No. 39384.

Topography.

The Topographic Mapping of the United States bv the U. S. Geological Survey. H. M. Wilson. Gives the early history of the work, showing its utility, and describing methods and cost in present article. 2700 w. Eng News—Feb. 7, 1901. No. 39203.

MUNICIPAL.

Garbage Disposal.

A New Garbage Furnace at Atlanta, Ga. Describes a Lester furnace which has been in operation about one year, and has given satisfaction. 1200 w. Eng News—Feb. 7, 1901. No. 39206.

Garbage Disposal at Indianapolis, Ind. Gives an outline of the history of garbage disposal in this city, and describes the present reduction system. 1600 w. Eng News—Jan. 31, 1901. No. 39094.

Some Financial, Political and Sanitary Phases of Garbage Disposal. A brief description of a garbage furnace to be tested at one of the electric lighting stations in Chicago, with editorial discussion of various phases of the subject. 2400 w. Eng News—Feb. 14, 1901. No. 39259.

Havana.

Engineering Work in the City of Havana. Engravings showing changes in sanitary conditions, with abstract of report of Gen. Ludlow, giving details of interest. 2500 w. Eng News—Feb. 7, 1901. No. 39202.

Pavements.

The Cost of Asphalt Pavements. F. V. E. Bardol. A table giving itemized cost of base,. binder and wearing surface of asphalt pavements in 1900 in 44 cities, with a reduction of the figures to a uniform basis for comparison. 900 w. Eng Rec—Feb. 23, 1901. No. 39390.

Refuse Destructor.

Dust Destruction and Electric Lighting at Fulham. An illustrated account of a combined refuse destructor, electricity supply and disinfector in the Borough of Fulham, England. 5000 w. Lightning—Feb. 14, 1901. No. 39508 A.

Sanitation.

The Civil Engineer as a Guardian of the Public Health. J. B. Johnson. Reprint from Jour. Assn. of Engng. Socs. Concerning the duty of civil engineers to lead public sentiment, and secure sanitary conditions in cities and towns, such as the securing of clean streets, pure water, prompt removal and destruction of refuse, etc. 5300 w. Wis Engr—Jan., 1901. No. 39307 D.

Sewage Disposal.

The Ohio State Board of Health on Septic Sewage Disposal. A review of a report refusing permissión to Columbus to dispose of its sewage by septic treatment without subsequent filtration. 2100 w. Eng Rec—Feb. 2, 1901. No. 39130.

The Septic Tank Experiments at Pawtucket. Describes experiments covering 10 months and dealing with a very strong sewage. 1800 w. Eng Rec—Feb. 16, 1901. No. 39315.

Sewers.

Cleaning a Large Brick Sewer in Hartford, Conn. Frederick L. Ford. Describes the methods and gives the cost of cleaning 9,300 ft. of 3 to 6 ft. sewers. 1000 w. Eng Rec—Feb. 16, 1901. No. 39318.

New System of Sewer Ventilation. Illustrates and describes a system which claims not only to give continuous and efficient ventilation to any class of sewer, but to remove all obnoxious gases, and to prevent any bacteria being taken into the air. 1300 w. Engr, Lond—Feb. 8, 1901. No. 39375 A.

The Computation of the Cost of Pipe Sewers by Formulæ. W. G. Kirchoffer. Demonstration showing that the average cost of pipe sewers varies as the square of the depth of the trench in which it is laid. 3000 w. Wis Engr—Jan., 1901. No. 39312 D.

WATER SUPPLY.

Filtration.

Selecting a System for Filtration of Water. Floyd Davis. Discusses efficiency, original cost and operating expenses. 1000 w. Munic Engng—Feb., 1901. No. 39-119 C.

The Experimental Water Filters at New Orleans. Illustrated description of an inexpensive station for testing various water purification processes involving sedimentation and filtration with or without coagulation. 600 w. Eng Rec—Feb. 9, 1901. No. 39233.

Iron Removal.

Removal of Iron From the Water Supply of Superior, Wis. R. D. Chase. History of the water supply is given, with illustrated description of the plant. Gives details of the filter beds, clear water reservoir, aerator, etc. 4000 w. Eng News—Feb. 21, 1901. No. 39387.

Paris.

Supply of Water From Loing and Lunain to Paris (Adduction des Eaux du Loing et du Lunain). F. J. Feugères. Description of additional supplies of potable water to Paris with profiles of route, and illustrations of aqueduct and siphons. 3000 w. 1 plate. Géne Civil—Jan. 19, 1901. No. 39400 D.

Pollution.

Proposed Water Pollution Legislation in Indiana. A discussion of two bills before the Legislature aiming to give the State Board of Health a large measure of control over water pollution. 1000 w. Eng News—Feb. 14, 1901. No. 39260.

Purification.

Plant for Investigating the Purification of Mississippi River Water at New Orleans. Illustrated description of recently installed plant. 600 w. Eng News—Feb. 7, 1901. No. 39205.

Water Purification in Washington. Gives the reasons of R. Hering, G. W. Fuller and A. Hazen for recommending slow filters, sedimentation basins and the occasional use of a coagulant for purifying the Potomac River water. 800 w. Eng Rec—Feb. 23, 1901. No. 39388.

Reservoirs.

Reservoir Dams. A discussion of the disputed features in the design of high dams, both earth and masonry, referring particularly to hydrostatic pressures within the mass of the dam. 1500 w. Eng Rec—Feb. 9, 1901. No. 39231.

Vienna.

The Emperor Francis Joseph Water Supply (Der Kaiser Franz Josefs-Hochquellenleitung). F. Berger. A description of the new sources of potable water to be provided for Vienna, with an account of the preliminary studies prior to the construction of the works. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 18, 1901. No. 39442 B.

Water-Works.

The Arad Water Works and Fischer Plate Filters. Illustrated description of a method of sand filtration in a town in Hungary, and which has been adopted to a considerable extent on the Continent. 1200 w. Engng—Feb. 15, 1901. No. 39517 A.

Tokyo City Water Works. Brief illustrated description of the new system of water supply, which is based on the most approved practice. 1100 w. Engng—Feb. 1, 1901. No. 39286 A.

MISCELLANY.

Nature's Stores.

The Coming Exhaustion of Nature's Stores. Editorial on the economics and industrial changes to be anticipated in the coming century, reviewing some of the points needing the careful study of the engineer. 3300 w. Eng News—Jan. 31, 1901. No. 39093.

Nineteenth Century.

Nineteenth Century Engineering: Its Evolution, and Something of Its Beginnings in America. Edgar Marburg. An interesting review showing the progress and the benefits due to science. 7500 w. Pro Engs' Club of Phila—Feb., 1901. No. 39237 D.

Siberia.

Engineering Opportunities in Central and Southwestern Asia. A. H. Ford. Mr. Ford's second paper deals with the various engineering developments, railway, manufacturing, and mining, of Russian Asia, calling attention to the opening for Anglo-Saxon enterprise. 3500 w. Engineering Magazine—March, 1901. No. 39476 B.

ELECTRICAL ENGINEERING

COMMUNICATION.

Bank Telegraph.

The Forerunner of the Telephone. Edward A. Calahan. Illustrated description of instruments and the system for a bank and private line used before the invention of the telephone. 1500 w. Elec Wld & Engr—Feb. 23, 1901. No. 39534.

Cables.

Methods of Locating Faults in Underground Electric Cables. H. W. Fisher. Describes the methods used in daily practice, and also original methods which the writer has found of service. 11200 w. Pro Engs' Soc of W. Penna.—Dec., 1900. No. 39306 D.

Multiplex.

A Method for Multiplex Wire and Space Telegraphy (Eine Methode für Mehrfache Draht und Funkentelegraphic). Anders Bull. A paper before the Electrotechnical Society, suggesting a system of variable wave impulses, applicable to telegraphy with or without wires. 3000 w. Elektrotech Zeitschr—Jan. 31, 1901. No. 39462 B.

An Improved Simple Method of Multiplex Telegraphy (Vorschlag zu Einer Neuen Einfachen Methode der Vielfachtelegraphie). J. W. Giltay. The system is based on the use of alternating currents of different periodicity. 2000 w. Elektrotech Zeitschr—Jan. 31, 1901. No. 39461 B.

Space Telegraphy.

Application of a Telephone Receiver to Wireless Telegraphy (Application Directe d'un Recepteur Telephonique à la Telegraphie sans Fil). MM. Popoff and Ducretet. Showing how the distance over which space telegraphy can be operated is materially increased by the use of telephone receivers. 1000 w. Comptes Rendus—Dec. 31, 1900. No. 39420 D.

A Tuning System for Wireless Telegraphy. Anders Bull. An explanation of the principle of a system invented by the writer, for preventing the interception of messages by stations for which they were not intended. 2200 w. Elect'n, Lond—Feb. 8, 1901. No. 39360 A.

Multiple Spark Telegraphy. Editorial review of Prof. Slaby's lecture upon the practicability of using wireless telegraphy without interference of messages. 2500 w. Engng—Feb. 8, 1901. No. 39369 A.

Steering Torpedoes by Wireless Telegraphy. An illustrated account of the work of an English electrician, Cecil Varicas, and successful experiments in steering submarine torpedoes. 1600 w. Sci Am—Feb. 16, 1901. No. 39294.

The Action of Apparatus for Wave Telegraphy (Ueber die Richtfähigkeit der Wellentelegraphischen Apparate). Dr. R. Blockmann. An examination of the propagation of electrical waves, and the manner in which they may be employed to transmit messages. 2500 w. Elektrotech Zeitschr—Jan. 24, 1901. No. 39458 B.

Stock Tickers.

The Evolution of the Stock Ticker. Edward A. Calahan. An interesting account of the invention and development of this apparatus. 2800 w. Elec Wld & Engr—Feb. 9, 1901. No. 39264.

Telephone Lines.

A Few Notes on the Construction of Telephone Lines in Norway. Illustrated description of some peculiarities in construction, seen by the writer. 1800 w. Elec Rev, Lond—Feb. 8, 1901. No. 39376 A.

Telephone Exchange.

The Automatic Telephone Exchange at New Bedford, Mass. Alton D. Adams. Explains the general principles of the system, and gives an illustrated detailed description of the apparatus and station. 2500 w. Elec Wld & Engr—Feb. 9, 1901. No. 39262.

The Independent Telephone Exchange at Rochester, N. Y. Illustrated description of a modern equipped exchange. 1000 w. Elec Wld & Engr—Feb. 23, 1901. No. 39531.

Telephones.

The Dynamo in Recent Telephone Practice. D. M. Bliss. An illustrated description of apparatus now considered standard for supplying exchange systems, the arrangement of circuits, etc. The dynamo is especially considered. 2500 w. Elec Wld & Engr—Feb. 23, 1901. No. 39532.

The Telephone Auto-Commutator. An illustrated explanation of the principle of a system recently installed in France for calling subscribers without the aid of the central office. 1100 w. Sci Am—Feb. 9, 1901. No. 39208.

The Telephone Company of Guatemala. Brief illustrated description of the system. 700 w. Elec Rev, N. Y.—Feb. 16, 1901. No. 39329.

The Valuation and Taxation of Telephone Companies in Michigan. W. J. Rice. An explanation of the work of the Michigan Board of State Tax Commission; the results reached as a basis for the appraisal of telephone properties, and matters related. 3700 w. Elec Wld & Engr—Feb. 2, 1901. No. 39143.

DISTRIBUTION.

Alternating Currents.

Alternating-Current Development in Austria. Frank C. Perkins. An illustrated account of some installations of interest. 1500 w. W Elect'n—Feb. 23, 1901. No. 39505.

Capacity in Alternate-Current Working. An interesting letter from Dr. Maurice de Hoor, criticizing some statements in W. M. Mordey's paper. 1800 w. Elect'n, Lond—Feb. 8, 1901. No. 39364 A.

Circuit Breakers.

Some Recent Tests of Magnetic Circuit Breakers. Hugh A. Brown. Investigations which formed a part of a graduation thesis at Columbia University, the object being to determine how accurately circuit breakers act, and their working. 1500 w. Elec Wld & Engr—Feb. 9, 1901. No. 39263.

Cut-Out.

A New Automatic Cut-Out. H. Müller. Illustrated description of a new design. 1000 w. Elect'n, Lond—Feb. 8, 1901. No. 39363 A.

Three-Phase.

The Development of Three-Phase Working in the Twentieth Century. Val. A. Fynn. Considers briefly the items which make up a three-phase transmission and distribution, the improvements desirable, and those that may be expected, and cases where the application of this system would seem consistent with economy. 3500 w. Elec Rev, Lond—Feb. 1, 1901. No. 39275 A.

ELECTRO-CHEMISTRY.

Accumulators.

See Mechanical Engineering, Automobilism.

Autoxidation.

Autoxidation and Its Connection with the Theory of Ions (Ueber die Autoxydation und Ihren Zusammenhang mit der Theorie der Ionen). F. Haber. An examination of the theory of ions in connection with the electrochemical action of galvanic elements. 3000 w. Zeitschr f Electrochemie—Jan. 31, 1901. No. 39466 G.

Reflectors.

The Cowper-Coles Electrolytic Process for the Manufacture of Parabolic Reflectors. An illustrated account of an ingenious process. 2800 w. Elect'n, Lond—Feb. 8, 1901. No. 39362 A.

ELECTRO-PHYSICS.

Accumulators.

The Resistance of Lead Plate Accumulators (Ueber den Widerstand von Bleiakkumulatoren). F. Dolezalek and R. Gahl. With diagrams giving the results of numerous measurements, and showing the distribution of resistance between the two electrodes. Two articles, 3500 w. Zeitschr f Elektrochemie—Jan. 24, 31, 1901. No. 39465 each G.

Apparent Hysteresis.

Apparent Hysteresis in Torsional Magnetostriction, and Its Relation to Viscosity. C. Barus. Experimental investigations with results. 4200 w. Am Jour of Sci—Feb., 1901. No. 39187 D.

Luminescence.

The Luminescence of a Rarified Gas Around Metallic Wires (Luminescence d'un Gaz Raréfie autour des Fils Metalliques). J. Borgman. A study of the luminous effects produced when a wire connected to one pole of an induction coil passes through a rarefied gas. 1200 w. Comptes Rendus—Dec. 24, 1900. No. 39419 D.

GENERATING STATIONS.

Alternators.

The Three Phase Alternators of the Metropolitan Street Railway Company of New York City. Harris J. Ryan. A study of the design and performance of those alternators, which are typical of the latest American practice. Ill. 3800 w. Sib Jour of Engng—Feb., 1901. No. 39529 C.

Austria.

The Abbazia Electric Station (Des Elektrizitätswerk Abbazia). A brief illustrated description of the steam power electric-lighting station at Abbazia in the Austrian Riviera. 1200 w. Zeitschr d Ver Deutscher Ing—Jan. 26, 1901. No. 39434 D.

Converters.

Synchronous Converters. W. E. Goldsborough. Read before the Northwestern Elec. Assn. Considers this useful electrical device, explaining the theory of its working, and its management. 4500 w. Elec Rev, N. Y.—Feb. 2, 1901. No. 39140.

Generating Set.

Generating Set of 1,200 Kilowatts (Groupe Electrogène de 1,200 Kilowatt). Detailed description of horizontal compound engine of 1,000 h. p. by the Brünn Machine Works and 1,200 k. w. three-phase generator by Ganz & Co., exhibited at Paris. 2500 w. 1 plate—Génie Civil—Jan. 26, 1901. No. 39403 D.

Hydraulic Plant.

The Water-Power Plant at Massena, N. Y.; St. Lawrence Power Co. Illustrated description of the canal, dam and power-house, electrical equipment, etc. Eng News—Feb. 21, 1901. No. 39383.

Isolated Plants.

Cost Determination in Isolated Electric Plants. P. R. Moses. Discussing the methods of recording and classifying cost data so as to enable intelligent conclusions to be deduced. 3000 w. Engineering Magazine—March, 1901. No. 39477 B.

Northwich, England.

Northwich Electricity Works. Illustrated detailed description of an installation having interesting features. 2800 w. Elec Rev, Lond—Feb. 1, 1901. No. 39277 A.

Parallel Running.

Relation of Characteristic Curves of Direct-Current Dynamos to Parallel Operation. Alton D. Adams. Shows curves for series, shunt, evenly compounded and over-compounded dynamos, discussing the results, indicated. 900 w. Am Elect'n—Feb., 1901. No. 39186.

Running Continuous-Current Electric Generators in Parallel. Explains methods of connection, and discusses in detail the distribution of the current. Ill. 2500 w. Col Guard—Feb. 8, 1901. No. 39365 A.

Prices.

The Determination of the Price of Current for Electric-Supply Stations (Die Bemessung des Strompreises bei Elektrizitätswerken). K. Wilkens. An examination of daily and monthly diagrams for the purpose of determining an equitable basis for charges; the results are compared for a number of stations. 3000 w. Elektrotech Zeitschr—Feb. 7, 1901. No. 39463 B.

Rates.

The Rate Question. H. L. Doherty. A discussion of the relative value of the meter and the flat rate systems, and advocating the charging for electric power by a combination of fixed and variable charges. 1800 w. Am Gas Lgt Jour—Feb. 4, 1901. No. 39136.

Switchboards.

Switchboard Construction. John H. Hertner. Discusses points to be considered in switchboards of various sizes and purposes, the materials used, etc. Ill. 2300 w. Engr, U. S. A.—Feb. 1, 1901. No. 39197.

Transformers.

The Design of Transformers. W. B. Woodhouse. Explains the method of design, the two types of modern transformers, and the advantages of each, etc. 1700 w. Elect'n, Lond—Feb. 15, 1901. Serial. 1st part. No. 39514 A.

Transformer Incidents. Thomas W. Varley. Gives some interesting incidents in the use of transformers, explaining the causes. 800 w. Elec Wld & Engr—Feb. 23, 1901. No. 39533.

Wigan, England.

Wigan Electricity Works. Illustrated description of the works and their equipment. 6600 w. Elec Engr, Lond—Feb. 1, 1901. No. 39215 A.

LIGHTING.

Address.

Electrical Illumination at the Beginning of the Twentieth Century. Brief of a lecture by Dr. Louis Bell given before the N. Y. Elec. Soc. 5600 w. Elec Wld & Engr—Feb. 9, 1901. No. 39265.

Arc Lamps.

Arc-Lamp Standardization. Harold Almert. Read before the Chicago Elec. Assn. Discusses the difficulties in arc-light photometry, and the unsuitability of the candle as a standard for practical use. 2300 w. W Elect'n—Feb. 2, 1901. No. 39152.

The Economic Radius of Arc-Lamp Service from Constant-Pressure Dynamos. Alton D. Adams. Discusses the operation of arcs directly from constant pressure circuits, the advantages and disadvantages. 3500 w. Elec Rev, N. Y.—Feb. 23, 1901. No. 39380.

Chicago.

Municipal Electric Lighting in Chicago. Edward B. Ellicott. Report by the city electrician, of 13 years' operation of municipal electric stations. 1600 w. Eng Rec—Feb. 23, 1901. No. 39391.

Incandescent Lamps.

The Efficiency of the Incandescent Lamp. Ed C. de Segundo. A discussion of this subject, quoting from paper by Arthur J. Rowland, read before the Franklin Inst. 1000 w. Elec Rev, Lond—Feb. 1, 1901. Serial. 1st part. No. 39276 A.

Legislation.

Penalties Under the Electric Lighting Acts. A review of points concerning the rights of consumers and "undertakers" in Great Britain. 2200 w. Engng—Feb. 1, 1901. No. 39289 A.

Switchboards.

Switchboards for Electric Lighting. J. H. Hertner. Brief review of the development and an illustrated description of the connections and arrangements of the modern switchboard. 2000 w. Engr, U. S. A.—Feb. 15, 1901. No. 39350.

MEASUREMENT.

Errors.

Errors in Magnetic Measurements Caused by Oxidation of Iron (Ueber die durch Oxydschichten des Eisens Verursachten Fehler Magnetischer Messungen). H. Kamps. Discussing and computing the influence of films of oxide of various thicknesses. 5000 w. Elektrotech Zeitschr—Jan. 24, 1901. No. 39456 B.

Galvanometers.

The Hartmann and Braun Galvanometers (Les Galvanometers Hartmann et Braun). J. A. Montpellier. With illustrations of fine reflecting galvanometers exhiibted at Paris. 1800 w. Electricien—Jan. 19, 1901. No. 39467 B.

Insulation.

Testing the Insulation Resistance of a Conductor (Eine Einfache Methode zur Prüfung des Isolationwiderstandes von Leitungsmaterialen). Dr. J. Rabinowicz. The insulated conductor is immersed in water, the latter being in a circuit into which a condenser and galvanometer may be successively thrown. 1000 w. Elektrotech Zeitschr—Jan. 31, 1901. No. 39460 B.

Meters.

Small Meters for Electric Energy (Petits Compteurs d'Energie Electrique). Illustrated description of the meters for continuous and alternating currents, exhibited by the Allgemeine Elektrizitäts Gesellschaft at Paris. 2000 w. Electricien—Feb. 9, 1901. No. 39469 B.

Meter Testing.

The Method of Testing Alternating-Current Meters at the Reichsanstalt (Ueber Einrichtungen und Methoden zur Prüfung von Wechselstromzählern in der Physikalisch-Technischen Reichsanstalt). E. Orlich. A detailed account of the equipment of the testing department and the routine of actual work. 5000 w. Elektrotech Zeitschr—Jan. 31, 1901. No. 39459 B.

Observatory.

New Magnetic Observatory of the United States Government. An illustrated description of the buildings at Cheltenham, Md., and their equipment. 2200 w. W Elect'n—Feb. 9, 1901. No. 39296.

Testing.

Portable Cable-Testing Apparatus (Transportable Apparatenzusammenstellung für Kabeluntersuchungen). Prof. M. T. Edelmann. Describing and illustrating a convenient combination for testing insulation, capacity and resistance. 1200 w. Elektrotech Zeitschr—Jan. 24, 1901. No. 39457 B.

POWER APPLICATIONS.

Canal Traction.

The Development of Electric Traction on Canals. A summary of the work which has been done in the United States, and brief notice of recent work in Europe. 3500 w. Elec Wld & Engr—Feb. 2, 1901. No. 39142.

Fan Motors.

Electric Fans for 1901. Describes and illustrates various styles of direct and alternating-current fan motors. 7000 w. Elec Rev, N. Y.—Feb. 9, 1901. No. 39250.

The History and Development of the Electric Fan Motor. F. V. Henshaw. Reviews the history of this American invention, giving illustrations of various designs. 3800 w. Elec Rev, N. Y.—Feb. 9, 1901. No. 39249.

Fans.

Electric Fans in the Export Trade.

Arthur Stanley Riggs. A discussion of the present standing and future outlook. 2200 w. Elec Rev, N. Y.—Feb. 9, 1901. No. 39251.

Induction Motors.

Induction Motors in a Tobacco Factory. F. E. Bausch. Illustrated description of the power plant of the M. C. Wetmore Tobacco Co., of St. Louis, Mo., with a capacity of 100,000 lbs. of tobacco daily. 1000 w. Am Elect'n—Feb., 1901. No. 39184.

Mining Plant.

Electricity in Mining. Lawrence Birks. The first of a series of articles on the advantages of electrical installations. The present article deals principally with its use as an illuminant. Ill. 1600 w. Aust Min Stand—Jan. 10, 1901. Serial. 1st part. No. 39359 B.

The Electrical Installation at Ackton Hall Colliery. Illustrated description of a large light and power plant in England. 1800 w. Col Guard—Jan. 25, 1901. No. 39166 A.

The Electric Plant at the Carmaux Mines (Installations Electriques des Mines de Carmaux). A. Bainville. The gas from coke furnaces is used to supply steam for 1,400 h. p. generating sets. Plans for the generators, switch boards and distribution are given. 2000 w. Electricien—Jan. 26, 1901. No. 39468 B.

The Utilization of Electrical Machinery in Coal Mining. W. C. Mountain. On the necessity of introducing electrical machinery, and its application. Ill. 3000 w. Elec Rev, Lond—Feb. 8, 1901. No. 39378 A.

Printing Office.

The New Plant of the Curtis Publishing Co. Charles Henry Davis and John S. Griggs, Jr. Illustrated description of a large printing establishment with electric power transmission throughout. 4400 w. Eng Rec—Feb. 23, 1901. Serial. 1st part. No. 39389.

Review.

Electrical Apparatus. A long illustrated review of the development of the electric motor from the earliest devices down to the present time. 1500 w. Engr, U. S. A. —Jan. 15, 1901. No. 39080.

TRANSMISSION.

California.

Transmission System of the Bay Counties Power Company, California. Describes a large undertaking designed for 60,000 volts line pressure, supplying power to the mining districts in Yuba and Nevada Co.'s, and to Oakland. 1200 w. Elec Wld & Engr—Feb. 16, 1901. No. 39326.

South Africa.

Experience with Electric Power Transmission in South Africa. Abstract of a paper by H. J. S. Heather, presented to the Institution of Civil Engineers, describing troubles caused by lightning, in electric transmission plants in South Africa, and the growth of a direct current system, and its final transformation to an alternating plant. 2200 w. Eng Rec—Feb. 9, 1901. No. 39236.

Sumatra.

A Power Transmission Plant in Sumatra. Illustrates and describes a water-driven three-phase power-transmission plant installed at the Redjang-Lebong gold mine. 2000 w. Elect'n, Lond—Feb. 8, 1901. No. 39361 A.

MISCELLANY.

Education.

Self-Instruction in Electrical Engineering. W. H. Radcliffe. Suggestions and lists of helpful literature for the aid of those wishing to study this subject. 1300 w. Elec Rev, N. Y.—Feb. 16, 1901. No. 39330.

Trade Education of Central-Station Employees. D. C. Jackson, F. A. Copeland and H. L. Doherty. Abstract of a report of a committee of the N.-W. Elec. Assn., appointed to consider the advisability of encouraging employees to enroll themselves in correspondence schools. 6000 w. W Elect'n—Jan. 26, 1901. No. 39073.

Obstruction.

Official Obstruction of Electric Progress. J. A. Fleming. Reviews briefly the great electrical inventions, noting the nationality of the inventors, and discusses the reasons why electrical inventions have moved so slowly in Great Britain, and the reforms needed. 6200 w. Nineteenth Cent—Feb., 1901. No. 39333 D.

GAS ENGINEERING

American Methods.

Business Sketches in America. E. W. T. Richmond. The first of a series of articles on points of interest to the gas industry. 5800 w. Jour Gas Lgt—Jan. 29, 1901. Serial. 1st part. No. 39273 A.

Gas Matters in the United States. An explanation of methods of business in gas undertakings, a description of American types of gas-engines, cooking and heating practice, etc. 7500 w. Jour Gas Lgt—Feb. 5, 1901. No. 39297 A.

Furnace Gas.

The Utilisation of Gas from Blast Furnaces and Coke Ovens (Utilisation des Gas de Hauts Fourneaux et de Fours à

Coke). E. Deschamps. The first installment of a serial discussing the subject of the utilisation of furnace gases in gas engines. Serial. Part I. 4000 w. Rev de Mécanique—Jan., 1901. No. 39422 H.

Gas Fitting.

Practical Gas Fitting. Henry Vardiman, in the *Engineering Review*. Suggestions regarding the places for and kind of fixtures; the sizes and lengths of pipes for different kinds of gas, etc. 1800 w. Pro Age—Feb. 15, 1901. No. 39344.

Gas Heating.

The Alleged Dryness of Air in Rooms Warmed by Gas-Fires. Thomas Fletcher. A report of careful experiments made in such a form that they can be repeated and verified. 1500 w. Jour of Gas Lgt—Feb. 12, 1901. No. 39507 A.

Holders.

Steel Gas Holders. W. A. Baehr. A topical discussion pointing out some of the problems connected with the foundation, the tank, the holder and the guide framing. 1500 w. Wis Engr—Jan., 1901. No. 39310 D.

Instruction.

Technical Instruction in Gas-Making in Germany. Details of an important scheme for the training of foremen, of managers, and of lighting engineers. 3000 w. Gas Wld—Feb. 2, 1901. No. 39274 A.

"Mond" Gas.

The Manufacture of "Mond" Gas in Central Stations. A. Rollason. Read before the South Staffordshire Ir. and Steel Inst. Illustrates and describes the Mond gas plant, giving much information concerning its operation, and a statement of the advantages. 2200 w. Col Guard—Feb. 15, 1901. No. 39524 A.

Street Lighting.

The Lighting of City Streets. E. C. Jones. Read before the Convention of the League of California Municipalities. Principally descriptive of the Welsbach burners used in San Francisco, with comparative cost of different lights. 2400 w. Jour of Elec—Dec., 1900. No. 39145.

Water Gas.

Regulating the Air Supply to Burners Consuming Mixed Coal and Water Gas. H. Leicester Greville. Remarks on the suitable regulation, and the faults due to the appliances rather than to the gas. 2000 w. Jour Gas Lgt—Jan. 22, 1901. No. 39107 A.

Water-Gas Generators (Gazogènes pour Gas à l'Eau). J. Deschamps. An examination of the Dellwik-Fleischer and the Strache processes, with diagrams showing the output and the composition of product. 2000 w. Génie Civil—Jan. 26, 1901. No. 39404 D.

MARINE AND NAVAL ENGINEERING

Armour.

The Disposition of British Battleship Armour. Editorial on the recently launched new class battleships, which are remarkable for their high speed, and for the greater distribution of their broadside armour. 2200 w. Engng—Feb. 15, 1901. No. 39518 A.

Balancing.

The Balanced and Unbalanced Engines of Torpedo Boat S. 42 (Vergleich Zwischen der Ausgeglichen und der Unausgeglichinen Maschine des Torpedobootes S. 42). Hans Mohr. A study of the problem of balancing four-crank engines, taking into account the finite length of the connecting rod. Two articles. 5000 w. Schiffbau—Jan. 8, 23, 1901. No. 39446 each D.

Boilers.

The Constructive Development of the Dürr Boiler in the German Navy (Die Konstruktive Entwicklung der Dürr-Kessel in der Deutschen Kriegsmarine). An account of tests of the Dürr water-tube boiler, and illustrations of various installations in vessels of the German navy. Serial. Part I. 4000 w. 2 plates. Schiffabu—Feb. 8, 1901. No. 39448 D.

Coaling.

The Coaling Stations of the United States Navy. Waldon Fawcett. Illustrates and describes the station at New London, Conn., its equipment, etc. Also gives information of other stations to be similarly fitted. 1200 w. Am Mfr—Feb., 1901. No. 39150.

Cruisers.

New Russian First-Rate Protected Cruisers—Improved Bogatyr Type. An illustrated description of a vessel accepted as the standard for all future big protected cruisers in Russia. 1200 w. Engr, Lond—Feb. 8, 1901. No. 39374 A.

Education.

The Education of a Shipbuilder. Prof. J. H. Biles. From a lecture delivered before the Glasgow and West of Scotland Technical College Scientific Society. 2000 w. Naut Gaz—Feb. 7, 1901. No. 39219.

Ferryboat.

Magnificent Ferryboat. Illustration and

description of the new screw ferryboat "Chicago," for use in New York waters by the Pennsylvania Co. 2500 w. Naut Gaz—Feb. 14, 1901. No. 39341.

Freighters.

Large Ocean Freighters. Illustrated description of two new vessels under construction for the Boston Steamship Co. 1200 w. Naut Gaz—Feb. 7, 1901. No. 39216.

Splendid Lake Freighter. Illustration and brief description of the new steel steamship "Wilkes-Barre," built at the Union Dry Dock Company's plant, Buffalo. 700 w. Naut Gaz—Feb. 7, 1901. No. 39218.

Japan.

Shipping and Shipbuilding in Japan. Condensed information from recent publication by the Mercantile Marine Bureau. 800 w. Engng—Feb. 1, 1901. No. 39290 A.

Jet Propeller.

Centrifugal Hydraulic Propellers for Boats (Propulseur Centrifuge Hydraulique pour Bateaux). A. Dumas. Describing a system of jet propulsion recently tried with some success on the Seine. 1800 w. Génie Civil—Feb. 2, 1901. No. 39408 D.

Lake Commerce.

Commerce of Lake Superior. Information from an interesting report of government officials in charge of the St. Mary's Falls canal. 2700 w. Marine Rev—Feb. 21, 1901. No. 39398.

Lake Superior.

Early Days on Lake Superior. An account of conditions which existed before the opening of the Sault Ste. Marie canal. 4800 w. Marine Rev—Feb. 21, 1901. No. 39399.

Marine Engines.

Machinery for the New U. S. Battleships and Armored Cruisers. Illustrated description of the engines, representing very large units and all modern improvements. 1500 w. Marine Engng—Feb., 1901. No. 39200 C.

The Marine Engine. An illustrated review of the history of steam propulsion for vessels. 4800 w. Engr, U. S. A.—Jan. 15, 1901. No. 39076.

Maritime Commerce.

A Brief Sketch of the Origin and Development of the World's Shipping. Lawrence Irwell. An interesting review, giving some idea of the immense carrying trade, and the part taken by the different countries of the world. 2200 w. Marine Engng—Feb., 1901. No. 39199 C.

Merchant Marine.

The World's Merchant Marine and Shipbuilding. Facts from an article published in the *Frankfurter Zeitung* are discussed. 500 w. U. S. Cons Repts, No. 967. Feb. 20, 1901. No. 39348 D.

Naval Architecture.

Construction of Torpedo Boats and Destroyers. George Herbert Wilson. The first of a series of about twenty-five articles, containing subjects of interest to naval architects, shipbuilders, etc., and will apply to yachts and like craft as well as to the subject given. Ill. 3000 w. Marine Rev—Feb. 14, 1901. Serial. 1st part. No. 39334.

Pacific Liners.

The New Pacific Mail Liners. Illustration, with brief description of large vessels, nearing completion at the Newport News shipyard. 900 w. Naut Gaz—Feb. 7, 1901. No. 39221.

Pinnace.

Steam Pinnace (Dampfpinasse). Detailed description of steam pinnace built for the German navy, with sections of hull and machinery, and indicator diagrams taken during trial run. 1200 w. Schiffbau—Jan. 23, 1901. No. 39447 D.

Report.

Naval Lessons from America. Editorial on the report of Admiral Melville, Chief of the United States Bureau of Steam Engineering. 3000 w. Engng—Feb. 8, 1901. No. 39368 A.

Rules.

New Steamboat Rules and Regulations. Full text of the amended rules prepared under the direction of James N. Dumont. 2200 w. Naut Gaz—Feb. 21, 1901. No. 39527.

Shipbuilding.

Eastern Ship Building Co., New London, Conn. Illustrated description of interesting features of vessels undergoing construction, and of the company's plant. 2200 w. Marine Rev—Feb. 7, 1901. No. 39245.

Harlan & Hollingsworth Co., Wilmington, Del. Illustrates and describes some of the vessels constructed by this company. 2200 w. Marine Rev—Feb. 7, 1901. No. 39246.

Newport News Ship Building and Dry Dock Co. Illustrated description of improvements at this plant, and some of the vessels in process of construction. 2700 w. Marine Rev—Feb. 7, 1901. No. 39248.

Shipbuilding and Marine Engineering During 1900. A review of this industry, the present article being confined to the volume of work accomplished during the last year in the United Kingdom. 2700 w. Engr, Lond—Jan. 25, 1901. Serial. 1st part. No. 39169 A.

Union Iron Works, San Francisco. Gives an illustrated general description of the shops, ways and slips; vessels under construction, and of the novel features introduced. 5000 w. Marine Rev—Feb. 7, 1901. No. 39244.

Shipping Bill.

Senator Depew on the Shipping Bill. Reports a speech before the U. S. Senate indorsing the bill. 4000 w. Marine Rev—Jan. 31, 1901. No. 39137.

Ship Subsidies.

Substitutes for Ship Subsidies: A Reply. Alexander R. Smith. Answering the arguments set forth in paper by Louis Windmüller in the Jan. issue of the N. Am. Rev. 2000 w. N Am Rev—Feb., 1901. No. 39135 D.

Signaling.

Submarine Signaling. Arthur J. Mundy. An illustrated account of a device due to the writer and Prof. Elisha Gray, which sends a signal twelve miles. 1200 w. Sci Am—Feb. 2, 1901. No. 39099.

Steamers.

Peculiarities of Lake Steamers. Theodore Lucas. Description, with illustrations of characteristics of construction, suggesting improvements and considering the fitness of this type for coast service. 1400 w. Marine Rev—Jan. 31, 1901. No. 39138.

River and Bay Steamers of the Atlantic Coast. Theodore Lucas. The first of a series of articles to treat on various important subjects of interest to shipbuilders, owners and students of naval architecture. Ill. 1500 w. Naut Gaz—Feb. 7, 1901. No. 39217.

Steamship "Grecian" of the Boston and Philadelphia S. S. Co.'s Fleet. Illustrated description of a modern coast line vessel. 1500 w. Marine Engng—Feb., 1901. No. 39201 C.

Submarine.

Early Submarine Warfare. An account of early attempts at building submarine vessels for war purposes. 2000 w. Engr, Lond—Feb. 1, 1901. No. 39281 A.

Submarine Boats. Discusses the attitude of the French Government to the subject of submarine navigation, and gives an illustrated description of the Nordenfeldt submarine boat for Turkey, built in 1887. 3300 w. Engr, Lond—Jan. 25, 1901. Serial. 1st part. No. 39170 A.

The American Submarine Boats. Waldon Fawcett. Information concerning the boats now building and the trials to be made with them. Ill. 1500 w. Am Mfr —Feb. 14, 1901. No. 39343.

Tugboat.

Ocean Tugboat. Description of the "Cuba," now under construction at the shipyard of the Bath Iron Works. 1200 w. Naut Gaz—Feb. 7, 1901. No. 39220.

Wrecking.

To Raise the "Maine." A brief account of the methods by which the successful contractors propose to raise this vessel, and also the "Alfonso XII." 600 w. Ir Age—Feb. 14, 1901. No. 39252.

Yachts.

Elegant Steam Yacht. Illustrated description and plans of the new craft for Leonard Lewishon under Construction at Morris Heights, N. Y. 700 w. Naut Gaz —Jan. 31, 1901. No. 39106.

The Hamburg-American Yacht, "Prinzessin Victoria Luise." Illustrated description of a vessel specially designed for pleasure tours. 1100 w. Sci Am—Feb. 9, 1901. No. 39209.

Yacht Construction During 1900. Illustrates and describes some of the yachts built at Morris Heights, N. Y. 1200 w. Marine Rev—Feb. 7, 1901. No. 39247.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

The Weight of an Electric Accumulator for the Propulsion of a Vehicle (Recherche du Poids d'Accumulateurs Electriques Nécessaires à la Propulsion d'un Vehicle). D. Dujon. A mathematical investigation, deriving formulas for practical application, with tables. 3000 w. Revue Technique—Jan. 25, 1901. No. 39412 D.

Ball Bearings.

Ball Bearings, Big Wheels, and Other Matters. A discussion of motor car development, comparing the experimental results of Prof. Vernon Boys with the results obtained by calculation by Dr. Luxenberg and drawing conclusions regarding the general aspects. 2500 w. Auto Jour—Feb., 1901. No. 39510 A.

Bicycles.

Motor Bicycles. Reviews some of the peculiar characteristics of the bicycle, and considers the application of a motor, and points of construction. 2300 w. Auto Jour—Feb., 1901. No. 39513 A.

Some Experiences of Motor Bicycles. Joseph Pennell. An account of the writer's experiences in making an extended trip through Europe. General discussion. 10000 w. Jour Soc of Arts—Feb. 8, 1901. No. 39349 A.

Chicago.

New Electric-Vehicle Service Proposed for Chicago. Relating to a proposed service of 'buses and cabs at low rates. Ill. 800 w. W Elect'n—Jan. 26, 1901. No. 39072.

Commercial Vehicles.

Automobiles in Business. R. H. Thurston. On the conditions to be met, the requirements, and principles demanded for success; with a comparison of various kinds of motive power. 3000 w. Horseless Age—Feb. 6, 1901. No. 39192.

Mechanically Driven Wagons for the Transportation of Merchandise. Henri G. Chatain. Classifies the merchandise to be transported, and discusses the motive powers best suited to the work, giving the first place to steam. 1400 w. Horseless Age—Feb. 6, 1901. No. 39194.

Steam Freight Wagons. Discusses the difficulties to be overcome and the requirements, showing that for loads of 1,000 pounds and over, steam is the only power. 1400 w. Horseless Age—Feb. 6, 1901. No. 39193.

The Electric Automobile for Business Purposes. R. A. Fliess. Giving data of actual performance of electric delivery wagons, with numerous tables of mileage, demonstrating the success of electricity for light service. 5600 w. Horseless Age—Feb. 6, 1901. No. 39195.

Compensating Gear.

Compensating Gear for Motor Vehicles—Its History and Development. Sidney Russell. Reviews the earlier methods of driving, the present article bringing the history down to 1830-33. Ill. 3000 w. Auto Jour—Feb., 1901. Serial. 1st part. No. 39511 A.

Design.

The Influence of Climate, Road and Load Conditions on Business Automobile Design. Walter L. Bodman. Considers the difficulties to be met in the manufacture of these vehicles, the cost of the work, etc. 5000 w. Horseless Age—Feb. 6, 1901. No. 39196.

Electric Vehicle.

Holson Two-Wheeled Electric Vehicle. Illustration and brief description of a vehicle consisting of a seat and carriage frame suspended between two large wheels, the electric motors being in the hubs of the wheels. 1200 w. W Elect'n—Feb. 23, 1901. No. 39506.

Exhibition.

The Austrian Automobile Exhibition at Vienna, 1900 (Die Oesterrischische Automobil-Austellung in Wien, 1900). Prof. L. Czischek. A general description, with numerous illustrations, of the various vehicles exhibited. 2000 w. 3 plates. Zeitschr d Oesterr Ing u Arch Ver—Feb. 1, 1901. No. 39445 B.

Gasoline Vehicles.

Road Repairs Upon Gasoline Vehicles. Albert L. Clough. Suggestions concerning ways of temporarily remedying mishaps. 3200 w. Horseless Age—Feb. 20, 1901. No. 39379.

The Inspection of Gasoline Vehicles. Albert L. Clough. Calls attention to the importance of inspection before starting, giving suggestions of such details as are of special consequence. 3300 w. Horseless Age—Feb. 13, 1901. No. 39292.

Housing.

Winter Use and Housing of Automobiles. Albert L. Clough. Discusses care needed to secure these vehicles from damage from freezing temperatures. 1000 w. Horseless Age—Jan. 30, 1901. No. 39068.

Motor Cars.

Motor Cars in Paris. A discussion of the motor carriage industry, and the development as shown in the character of the exhibits at the annual show organized by the Automobile Club de France in the Grand Palais in Paris. 4000 w. Engr, Lond—Feb. 15, 1901. No. 39521 A.

Proposed Trial.

The 1,200 Miles Trial. Mark Mayhew. Extracts from a paper read before the Automobile Club of Gt. Britain and Ireland. A discussion of where the trial should be held; the legal limit of speed in England, etc. 3000 w. Auto Jour—Feb., 1901. No. 39512 A.

Springs.

Springs for Automobiles. M. C. Krarup. Discusses this subject, considering the rules for the design of springs for railway coaches, and horse-drawn carriages, and the factors to be considered in springs for automobiles. Ill. 2300 w. Horseless Age—Jan. 30, 1901. Serial. 1st part. No. 39067.

HYDRAULICS.

Hydraulic Plant.

The Hydraulic-Electric Works of Saut-Mortier (Usine Hydro-Electrique du Saut-Mortier). J. Claudet. An illustrated description of the plant by which 3,000 h. p. is derived from the river Ain, in the department of the Jura, France. 2000 w. Génie Civil—Feb. 9, 1901. No. 39409 D.

See Electrical Engineering, Generating Stations.

Niagara.

The New Wheelpit of the Niagara Falls Power Company. Illustrated description of a wheelpit 20 x 463 ft. in plan and 180 ft. deep, and a tunnel 618 ft. long, for the development of 55,000 h. p. 1400 w. Eng Rec—Feb. 16, 1901. No. 39317.

Pumps.

Cornish and Direct-Acting Duplex

Pumps. J. Renshaw. Comparison of these pumps in reference to permanent pumping plants in mines in which the water is below the temperature of about 70 or 75° Fahr. 1400 w. Min & Sci Pr—Feb. 2, 1901. No. 39198.

Turbines.

Special Report Upon Turbines and Their Regulators at the Paris Exposition of 1900 (Specialbericht über die Turbinen und deren Regulatoren au der Weltausstellung in Paris, 1900). Prof. F. Prasil. Giving details of various wheels and their governors, especial attention being devoted to the latter. Serial, Part I. 1500 w. Schweizerische Bauzeitung—Feb. 9, 1901. No. 39453 B.

Water Power.

Water Power. Brief review of methods of utilising water power. Ill. 1500 w. Engr, U. S. A.—Jan. 15, 1901. No. 39081.

Water-Wheels.

Ingenious Water-Wheels. Waldon Fawcett. Illustrates and describes some novel water-wheels in use in Nebraska and other western points, for irrigating purposes. 1000 w. Sci Am—Feb. 16, 1901. No. 39295.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball Bearings for Given Loads (Kugellager für Beliebige Belastungen). R. Stribeck. An account of tests made upon steel balls to ascertain deformation under pressure; with applications of the results to the design of ball bearings. Two articles, 10000 w. Zeitschr d Ver Deutscher Ing—Jan. 19, 26, 1901. No. 39433 each D.

See also Automobilism.

Brass.

Brass Scrap. C. Vickers. Suggestions for cleaning and using chips. 700 w. Am Mach—Jan. 31, 1901. No. 39086.

Casting.

Casting a Tangye Engine Bed. R. H. Palmer. Illustrated detailed description of the manner of making the casting. 2000 w. Am Mach—Feb. 14, 1901. No. 39321.

Centrifugal Casting. A. E. Fay. The author endeavors to give a complete history of the subject, especially describing the three important practical applications which have been made, setting forth the advantages which have been claimed and demonstrated. Ill. 3800 w. Ir Age—Feb. 28, 1901. No. 39535.

Cast-Iron Pipe.

Cast Iron Pipe in the United States. The first of a series of articles proposing to enter fully into the commercial conditions of the industry, the details of the methods of manufacture, and the forms of pipe and pipe joints used for water and gas mains and other purposes. 1600 w. Engr, Lond—Feb. 15, 1901. Serial. 1st part. No. 39520 A.

Dies.

A Forming Die. William M. Spry. Illustrates the bending die and a sample of the bent-up punching, giving description. 900 w. Am Mach—Feb. 7, 1901. No. 39181.

Drawing, Forming and Beading Shells. Joseph V. Woodworth. Illustrates and describes a set of dies for reducing a flat blank of soft sheet brass to the finished shape shown. 1300 w. Am Mach—Jan. 31, 1901. No. 39085.

Electrical Manufacturing.

Machine Tools and Outfit for Electrical Manufacturers. W. H. Booth. A discussion of the modern system of manufacture, the importance of possessing modern high-class machine tools, methods, and suggestions for improvement. 4000 w. Elec Rev, Lond—Feb. 8, 1901. No. 39377 A.

Engine Works.

A Canadian Engine Works. Norman Patterson. An illustrated article, giving a brief description of some of the processes of manufacturing practiced in the works of the Robb Engng Co., at Amherst, N. S. 2000 w. Can Elec News—Feb., 1901. No. 39342.

Foundry.

The New Steel and Iron Foundries of the Sargent Company. Illustrated description of a fine plant recently erected at Chicago Heights. Ill. 1300 w. Foundry—Feb., 1901. No. 39147.

Foundry Iron.

Foundry Iron. Captain Henning. Showing that chemical and physical investigations are of value to the foundry industry and equally necessary at the blast furnace to secure reliable results. 1200 w. Jour Am Found Assn—Feb., 1901. No. 39056 C.

Foundry Notes.

Ladles and Floor Molding. William Pilton. Illustrated description of appliances and methods used in the foundry of the Niles Tool Works Co. 800 w. Am Mach—Feb. 7, 1901. No. 39180.

Gear Cutting.

The Bilgram Automatic Generating Gear Cutter for Spur and Spiral Gears. Illustrates and describes the machine and its action. 1300 w. Am Mach—Jan. 31, 1901. No. 39087.

Gearing.

High Speed Toothed Gearing. James Christie. A record of what has been done in recent years, as much higher speeds are now successfully attained than formerly. Ill. 1500 w. Pro Engs' Club of Phila—Feb., 1901. No. 39239 D.

Interchangeable Gearing. Wilfrid Lewis. Advocating the general use of the involute system with an obliquity of 22½°, to avoid interference in low-numbered pinions. 4000 w. Pro Engs' Club of Phila—Feb., 1901. No. 39240 D.

Jigs.

A Common Drilling Jig. D. E. MacCarthy. Illustrated description of jig for drilling odd holes in a casting. 300 w. Am Mach—Feb. 7, 1901. No. 39183.

Processes of Jig Making. C. H. Rowe. Gives methods in use for the building of parts of jigs and the exact locating of holes. 1600 w. Am Mach—Feb. 7, 1901. No. 39182.

Lathes.

A New, Heavy Pattern, Two Spindle Lathe. Illustrated description of redesigned McCabe lathe. 800 w. Am Mach —Feb. 7, 1901. No. 39178.

Boring Head and Foot-Stocks of Lathes. A. B. Christman. Illustrates and briefly describes a method of finishing head and tail stocks, which the writer considers ideal. 300 w. Am Mach—Feb. 7, 1901. No. 39179.

Machine Tools.

Experiments on the Work of Machine Tools (Experiences sur le Travail des Machines Outils). M. Codron. The first portion is devoted to experiments with grinding machines, the power consumed being dynamometrically measured. Serial. Part I. 7500 w. Bull Soc d'Encour—Jan., 1901. No. 39425 G.

Light Lathes and Screw Machines. John Ashford. Considers the requirements of a present-day lathe for tool and ordinary work and how they may be fulfilled. Discusses various machine tools. Fully illustrated. 1500 w. Inst of Mech Engs—Feb. 15, 1901. No. 39528 D.

Manufacturing Plant.

A Modern Manufacturing Plant. Illustrated description of the new establishment of the Franklin Air Compressor Company, at Franklin, Pa. 1500 w. Ry Age—Feb. 22, 1901. No. 39394.

Molding.

Molding a Grinder Bed. An illustrated account of a novel and interesting molding operation. 1000 w. Am Mach—Feb. 21, 1901. No. 39381.

Pattern Working.

Thin Rings. John M. Richardson. Illustrated description of different methods of making thin ring patterns. 800 w. Am Mach—Feb. 14, 1901. No. 39322.

Premium Plan.

Spoiled Work—Inspection and the Use of Limits Under the Premium Plan. G. H. Hall. Advocating the charging of the workman with the time required to rectify spoiled work, and work beyond the established limits of variation. 1700 w. Am Mach—Feb. 14, 1901. No. 39320.

Rod Mills.

Record of Rod Mills and What Has Been Accomplished. William Garrett. A review of the progress in this field. 2500 w. Am Mfr—Feb. 21, 1901. No. 39393.

Rolling Mill.

Improved Mill for Rolling Edges Together with Flat Shapers. Albert G. Heinle. An illustration of the Heinle-Truxall rolling mill, with description of interesting features and operation. 1300 w. Am Mfr—Jan. 31, 1901. No. 39149.

Sampling.

Sampling Pig Iron. W. G. Scott. Discusses methods of sampling, and mixing by analysis. 2500 w. Foundry—Feb., 1901. Serial. 1st part. No. 39148.

Screw Threads.

International System of Metric Screw Threads (Système International des Filetages à Base Metrique). A review of the system proposed at Zurich, in 1898, together with the recent discussion concerning the dimensions of keys and wrenches. 7500 w. Bull Soc d'Encour—Jan., 1901. No. 39426 G.

Shop Equipment.

The Hardening and Tempering Plant of J. H. Williams & Co. Illustrated detailed description of the hardening and tempering equipment of a shop in Brooklyn, N. Y., and the methods employed. 2000 w. Ir Age—Feb. 7, 1901. No. 39172.

Shop Methods.

Recent Improvements in Technology (Ueber einige Technologische Neuerungen). Prof. F. Kick. A discussion of a number of shop methods and processes, mostly seen in a tour of Germany, Belgium, and Switzerland. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 25, 1901. No. 39443 B.

Shops.

An English Machine-Tool Shop. Illustrated description of the new workshops of Kendall & Gent, Belle Vue Station, Manchester, England. 900 w. Am Mach —Feb. 7, 1901. No. 39177.

Worm Gearing.

The Action of Worms and Worm-Wheels (Engrènement des Vis et Roues Héliçoidales). A translation of the paper of M. Ernst, recently presented before the *Verein deutscher Ingenieure*. Serial. Part I. 5000 w. Rev De Mécanique—Jan., 1901. No. 39423 H.

MATERIALS OF CONSTRUCTION.

Alloy.

A Useful Zinc Alloy. Walter J. May. Describes an alloy very useful in foundries and other places where it is desirable to have an easily milled metal of fair strength. 200 w. Sci Am—Feb. 2, 1901. No. 39102.

Beams.

Diagrams for Laying Out Beams of Uniform Strength. E. Kallberg. Gives diagrams of special use in the design of stakes for steam and hydraulic riveting machines, with directions for the method of using. 500 w. Am Mach—Feb. 21, 1901. No. 39382.

Bending.

The Stresses in Bent Prismatic Bodies (Beitrag zur Bestimmung der Beigungspannung in Gekrümmten Stabförmigen Korpern). A. Bantlin. A mathematical investigation, with practical applications to hooks, riveting machine frames, etc. Two articles. 7500 w. Zeitschr de Ver Deutscher Ing—Feb. 2, 9, 1901. No. 39437 each D.

Cast Iron.

Experiments on the Crushing Resistance of Cast Iron (Versuche über die Druckfestigkeit Hochwertigen Gusseisens). C. Bach. Data and results of tests, with especial reference to the dependence of strength to temperature. 1500 w. Zeitschr d Ver Deutscher Ing—Feb. 2, 1901. No. 39438 D.

POWER AND TRANSMISSION.

Belts.

Belt-Driving—Its History and Advantages. John Tullis. Read before the West of Scotland Tech. Col. Sci. Soc. Reviews the history, and gives information concerning the care and management of the belts, and various systems of driving. Ill. 3500 w. Am Mfr—Jan. 31, 1901. No. 39151.

Power Plants.

Power Plant Engineering, Past and Present. Editorial review of the progress in this field during the last century. 2700 w. Engr, U. S. A.—Jan. 15, 1901. No. 39083.

Power Plant of the McCormick Twine Mills. Illustrated detailed description. 2500 w. W Elect'n—Feb. 16, 1901. No. 39339.

Wire Ropes.

The Manufacture and Use of Wire Ropes. Brief account of this invention with illustrated descriptions of systems of transport. 2200 w. Ir & Coal Trds Rev—Feb. 8, 1901. No. 39367 A.

SPECIAL MOTORS.

Explosion Motors.

The Calculation of Explosion Motors for Vehicles (Le Calcul des Moteurs à Explosion pour Voitures). P. Colardeau. A discussion of the data upon which the power should be based, with tabulated information concerning existing standard vehicles. 2000 w. Génie Civil—Jan. 26, 1901. No. 39405 D.

Exposition.

Motors Other Than Steam Engines at the Paris Exposition (Les Moteurs autres que ceux à Vapeur à l'Exposition de 1900). G. Leroux. A general review of the gas, petroleum, hot air and similar motors exhibited at Paris. 5000 w. Soc Ing Civ de France—Dec., 1900. No. 39429 G.

Gas Engines.

Gas Engine Guarantees Technically Considered. William T. Magruder. Presented at meeting of the Nat. Assn. of Gas & Gasoline Eng. Mfrs. Outlines the history of these engines, and considers power rating, regulation, cost of running and fuel consumption. 4500 w. Power—Feb., 1901. No. 39065.

The Gas Engine. Illustrated historical review. 2800 w. Engr, U. S. A.—Jan. 15, 1901. No. 39082.

Weight in Gas Engines. E. W. Roberts. Discusses why gas engines are so heavy, and points out ways and means for obtaining the lightest practical engine within keeping with strength and efficiency. 3300 w. Rudder—Feb., 1901. No. 39090 C.

Solar Power.

A Solar Motor. Brief illustrated description of a device for utilizing the sun's heat, recently erected in South Pasadena. Cal. 450 w. Ry & Engng Rev—Feb. 23, 1901. No. 39397.

STEAM ENGINEERING.

Air Pumps.

Condenser Air Pumps. W. H. Booth. On the importance of inspection and attention to small leaks. 1300 w. Am Mach—Jan. 31, 1901. No. 39088.

Boilers.

Steam Boilers and Electric Stations. Discusses points concerning the choice of a type of boiler for a given pressure of steam, the working principles, and other matters of importance. 2300 w. Elec Rev, Lond—Feb. 15, 1901. No. 39509 A.

The Boiler. One of a series of articles on the evolution of apparatus for generating and utilising power. An illustrated review of the various improvements. 4000 w. Engr, U. S. A.—Jan. 15, 1901. No. 39074.

See Marine and Naval Engineering.

Boiler Plates.

Thicker Boiler Plates. R. S. Hale. Discusses the old and the present limits and the reasons for them. 1000 w. Power —Feb., 1901. No. 39064.

Combustion.

Economy in Fuel Combustion and Steam Generation. W. W. Christie. A study of boiler and furnace design, with reference to the production of steam with highest economy. The principles of furnace and chimney design are discussed. 4000 w. Engineering Magazine—March, 1901. No. 39472 B.

Compound Engines.

The Brand and L'Huillier Compound Engine of 150 Horse Power (Machine à Vapeur Compound de 150 Chevaux Système Brand et Huillier). A. Boudon. Illustrated description of Corliss and Poppet-valve cross-compound engine exhibited at Paris. 1000 w. 1 plate. Génie Civil—Feb. 9, 1901. No. 39410 D.

1,000-H. P. Compound Engine at the Paris Exposition. An illustrated description of an engine built by the Erste Brünner Maschinen-Fabriks-Gesellschaft, of Brünn, Austria. 500 w. Eng News—Feb. 14, 1901. No. 39257.

Compression.

The Influence of Clearance and Compression Upon Steam Consumption (Ein fluss des Schädlichen Raumes und der Kompression auf den Dampfverbrauch). H. Dubbel. A review of the researches of Zeuner, Doerfel, Dwelshauvers, and others, showing little or no loss due to compression, and attributing the results of Dwelshauvers to leaky valves and piston. 4000 w. Zeitschr d Ver Deutscher Ing—Feb. 9, 1901. No. 39439 D.

Connecting Rods.

The Problem of the Connecting Rod. W. F. Durand. A mathematical investigation of the motion of the connecting rod, including its acceleration, plus and minus during a revolution, together with the forces which are manifested as a result of much variable movement. 2000 w. Sib Jour of Engng—Feb., 1901. Serial. 1st part. No. 39530 C.

Engines.

The Stationary Engine. An illustrated review of the various stages in the development of this class. 6500 w. Engr, U. S. A.—Jan. 15, 1901. No. 39075.

Feed-Water.

Boiler Feeding and Feed-Water Heating. L. B. Mather. Discusses some methods of heating and means of delivering the feed water. 1200 w. Am Elect'n—Feb., 1901. No. 39185.

The Practical Purification of Feed Water (Considerations Pratiques sur l'Epuration des Eaux). J. Bertrand. Discussing especially the removal of carbonates by heat, and sulphates by lime and soda. 1500 w. Génie Civil—Jan. 19, 1901. No. 39402 D.

The Solubility of Sulphate of Lime (Etude sur la Solubilité du Sulfate de Chaux). M. Boyer-Guillon. An exhaustive account of experiments, showing the gradual manner in which the sulphate is precipitated as the temperature rises. 4500 w. Rev de Mécanique—Jan., 1901. No. 39421 H.

Heating.

The Steam Heating and Ventilating Plant at the Liesing Brewery (Dampfheizungs und Lüftungsaulage im Saalbau der Brauerei Liesing). J. H. Klinger. With plans and details of the steam heating of a large public hall in connection with a brewery in Vienna. 2500 w. 1 plate. Gesundheits-Ingenieure—Jan. 31, 1901. No. 39454 B.

Indicators.

The Indicator. Illustrated review of the important improvements on the instrument invented by James Watt. 1500 w. Engr, U. S. A.—Jan. 15, 1901. No. 39079.

Low Water.

Low Water Alarms and Laws Concerning Their Use. Abstract of a paper by F. C. Base, read before the International Convention of Inspectors at Indianapolis. Reasons for requiring the adoption of these alarms, with comments on the devices. 2400 w. Engr, U. S. A.—Feb. 15, 1901. No. 39351.

Marine Engines.

See Marine and Naval Engineering.

Mechanical Draft.

Application of Mechanical Draft to Stationary Boilers. Walter B. Snow. Considers the advantages of mechanical draft and shows that it costs less for installation than the chimney. Ill. 3000 w. W Elect'n—Feb. 16, 1901. No. 39340.

Power Tables.

Piston Speed. The first of a set of tables dealing with horse-power and other calculations connected with indicator diagrams, and steam engine capacities and efficiencies. It is desired that their accuracy shall be above question. 1000 w. Power—Feb., 1901. Serial. 1st part. No. 39066.

Rotary Engine.

The Colwell Rotary Engine, Reciprocating Engine and Condenser. Illustrates and describes recent inventions of W. S. Colwell, which possess features of interest. 2000 w. Sci Am Sup—Feb. 2, 1901. No. 39101.

The Hult Rotary Engine (Le Moteur Rotatif Hult). E. Dieudonné. An illustrated description of this Swedish rotary engine, exhibited at Paris. 1800 w. Revue Technique—Jan. 25, 1901. No. 39-413 D.

The Rotary Engine, and the Steam Turbine. A note on the rotary engine work, and an illustrated review of the steam turbine. 1800 w. Engr, U. S. A.—Jan. 15, 1901. No. 39078.

Steam Heating.

Heating from Central Stations. Alton D. Adams. Urging the distribution of steam and hot-water for heating purposes, giving figures relating to efficiency, cost, etc., and reasons for advocating a combined electric and heating plant. 1200 w. Munic Engng—Feb., 1901. No. 39118 C.

Some Notes on Central Station Heating. Read at meeting of the Heat. & Ven. Engs., at N. Y. Gives a review of the systems that have been employed, their advantages, and complications. 7000 w.

Steam Turbine.

Test of a 300 Horse Power de Laval Steam Turbine (Versuche an einer 300 Pferdigen de Laval-Dampfturbine). W. Jacobson. Giving data and results of trials showing a consumption of 15 to 18 pounds of water per brake horse-power-hour. 1200 w. Zeitschr d Ver Deutscher Ing—Feb. 2, 1901. No. 39436 D.

Units.

Engine and Generator Builder's Engine Type Units for Power Purposes. H. C. Ebert. Abstract of paper read at N. Y. meeting of the Eng. Builds.' Assn. of the U. S. Deals especially with engine type electric generating sets. 2200 w. Ir Age —Feb. 14, 1901. No. 39253.

Water-Tubes.

On the Tubes of Water-Tube Boilers. A general reply to the question of how to calculate the force which tends to draw a tube, in a water-tube boiler, out of the header or tube sheet to which it is secured. Ill. 2000 w. Locomotive—Dec., 1900. No. 39084.

Valve Diagram.

Laying Out a Valve Gear Diagram for a Corliss Valve Air Compressor. A. L. Goddard. Considers the laying out of a diagram for a two-stage Corliss valve compressor to compress 4,000 cu. ft, net of free air from an atmosphere of 14½ pounds to 100 pounds gauge at a piston speed of 600 feet per minute. Ill. 3000 w. Wis Engr—Jan., 1901. Serial. 1st part. No. 39308 D.

MISCELLANY.

Agricultural Machinery.

The Agriculture of the Future (L'Agriculture de l'Avenir). A. Ronna. With especial reference to the use of hydraulically operated machinery. 10000 w. Bull Soc d'Encour—Jan., 1901. No. 39424 G.

Aeronautics.

A New Flying Machine. Illustrated description of an ingenious machine recently designed by G. L. O. Davidson, of Scotland. It resembles a large bird with wings extended. 800 w. Sci Am—Feb. 2, 1901. No. 39160.

Arbitration.

Arbitration in Practice. H. W. Hoyt. An address before the Nat. Civic Fed. Conference, in Chicago. On the work of the Nat. Founders' Assn. in this field. 2300 w. Ir Trd Rev—Feb. 7, 1901. No. 39211.

Clock.

The Philadelphia City Hall Clock. Warren S. Johnson. Briefly explains the principles under which an accurate timepiece must work, and the problems encountered in the installation of the clock named, and the apparatus used. Ill. 5800 w. Jour Fr Inst—Feb., 1901. No. 39189 D.

Competition.

American Engineering Competition. Discusses the economic effects and their duration, the elements of success attending the management of large business concerns in the United States, and the difference between the spirit animating the working classes on either side of the Atlantic. 2200 w. Jour Gas Lgt—Jan. 29, 1901. Serial. 1st part. No. 39272 A.

Some Reflections Upon American Competition. George Harrison Sheffield. Paper read before the Newcastle-upon-Tyne Assn. of Students of the Inst. of Civil Engs. Discusses causes which are the outcome of American competition, and British conditions and tendencies. 6000 w. Engng—Feb. 1, 1901. No. 39291 A.

Education.

A Workingman's College. An illustrated account of the educational work at Cooper Union, New York. 5300 w. Ir Age—Feb. 7, 1901. No. 39173.

Elevators.

The Elevators at the Exposition of 1900 (Les Ascenseurs à l'Exposition de 1900). P. Dumesil. Detailed description of the various elevators, hydraulic, pneumatic, and electric, operated in all parts of the exposition. Three articles. 5000 w. Génie Civil—Jan. 19, 26, Feb. 2, 1901. No. 39401 each D.

Metric System.

The Metric System. W. H. Sargent. A discussion of its possibilities as a universal system. 1500 w. Mach, N. Y.—Feb., 1901. No. 39146.

Ventilation.

Ventilation and Heating of the American Exchange National Bank, New York. Illustrated description of a plenum system for the basement and first story of a 16-story office building, and an exhaust system for the same floors discharging through the cellar; also gives brief notes on other mechanical plant in the building. 2500 w. Eng Rec—Feb. 16, 1901. No. 39319.

MINING AND METALLURGY

COAL AND COKE.

Austria.

The Rossitz Coal District (Das Rossitzer Kohlenrevier). J. Sauer. A description of the geology and methods of mining in this important coal district of Moravia, Austria. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 19, 1901. No 39449 B.

Canada.

The Coal and Iron Industries of Eastern Canada. J. Stiven Barrie. A paper read before the West of Scotland Iron & Steel Inst. A review of the development of these industries and their present condition. 3800 w. Gol Guard—Feb. 15, 1901. No. 39525 A.

China.

The Tong Colliery, Kaiping, North China. Thomas Webster. From the Pro. of the So. Wales Inst. of Min. Engs. A description of the coal seams, methods of working, and the machinery used. 3800 w. Mines & Min—Feb., 1901. No. 39127 C.

Compressed Air.

Compressed Air Plant at a German Colliery. C. Jüngst, in *Zeitschrift für Berg, Hütten und Salinenwesen.* Illustrated description of plant at the Royal Camphausen Colliery, for driving the pumps, ventilating fans and winches. 2000 w. Col Guard—Feb. 8, 1901. No. 39366 A.

English Collieries.

The South Hetton Coal Company's Collieries and Their Equipment. Interesting account of the collieries of South Hetton and Murton; the latter is said to be the most arduous, difficult and expensive mining undertaking on record. Ill. 3200 w. Ir & Coal Trds Rev—Feb. 1, 1901. Serial. 1st part. No. 39278 A.

New Zealand.

The Supposed Coal Seam on Kaita Range, Near Greymouth. Alexander McKay. Report of the government geologist concerning an outcrop of coal-conglomerate in New Zealand. 1400 w. N. Z. Mines Rec—Dec. 17, 1901. No. 39353 B.

Russia.

The Russian Coal and Pig-Iron Industry. Dr. Neumark. A lecture delivered at the general meeting of the ironmasters of Upper Silesia. Translated and condensed from *Stahl und Eisen.* General information of these important industries, with special reference to that of Southern Russia. 2300 w. Ir & Coal Trds Rev—Feb. 15, 1901. Serial. 1st part. No. 39515 A.

Virginia.

Norton Coal Mines at Norton, Virginia. Robert Fleming. An illustrated description of the mines, the coal seams, and the methods of mining and handling the coal. 1200 w. Mines & Min—Feb., 1901. No. 39120 C.

COPPER.

Mount Lyell.

Native Copper at Mount Lyell. G. Thureau. On the peculiarities in the mode occurrence and the causes. 300 w. Aust Min Stand—Jan. 10, 1901. No. 39357 B.

New Zealand.

Native Copper at Kawan Island, New Zealand. W. H. Baker. On the occurrence of native copper in the crystalline state on mine timbers. 1000 w. N. Z. Mines Rec—Dec. 17, 1900. No. 39355 B.

Precipitation.

Precipitation of Copper From Its Solutions. Arthur W. Warwick. Notes on the precipitation of copper from its solution by iron. 600 w. Min Rept—Feb. 7, 1901. Serial. 1st part. No. 39241.

Smelting Works.

The British Columbia Copper Company's Smelting Works at Greenwood, B. C. Paul Johnson. Illustrated detailed description. 1800 w. Eng & Min Jour—Feb. 16, 1901. No. 39338.

Tasmania.

Notes on the Occurrence of Native Copper at Mt. Lyell, West Coast of Tasmania, with Observation Upon the Genesis of the Ores. G. Thureau. 4500 w. Min Jour—Jan. 26, 1901. No. 39270 A.

Tennessee Plant.

The Tennessee Copper Company's New Plant. A brief description of a plant in the Ducktown District for the development of copper ore deposits. 1000 w. Eng & Min Jour—Feb. 16, 1901. No. 39336.

GOLD AND SILVER.

Australia.

Gold Mining and Milling in Western Australia. A. G. Charleton. Mr. Charleton's second paper treats of the general geology of the western Australian fields, and the process of dry-blowing made necessary by the scarcity of water. 4500 w. Engineering Magazine—March, 1901. No. 39473 B.

British Columbia.

Placer Gold Mining Claims in British Columbia. A brief statement of the laws governing the locating and working of placer claims. 1300 w. U. S. Cons Repts, No. 956—Feb. 8, 1901. No. 39174 D.

California.

The Gold Mines of California (Les Mines d'Or de la Californie). A. Bordeaux. A study of gold mining in California, from a geological standpoint. Serial, Part I. 7500 w. 3 plates. Rev Univ des Mines—Jan., 1901. No. 39417 F.

Concentration.

Concentrating Tests and Calculations. Otto F. Pfordte. The necessity of a finer system of testing is presented, and suggestions of tests to be applied are given. 2000 w. Trans Am Inst of Min Engs—Feb., 1901. No. 39228 C.

Cripple Creek.

The Gold Coin Mine. Arthur Lakes. A history of its development and a description of the mines, the surface plant and miners' club-house. Ill. 2000 w. Mines & Min—Feb., 1901. No. 39121 C.

Deposits.

Cave Ore Deposits. Arthur Lakes. Illustrated description of peculiar deposits of silver and copper ores in caves at the Red Mountain mines, Colorado. 2200 w. Mines & Min—Feb., 1901. No. 39128 C.

Gold Milling.

Electro-Silvered versus Plain Copper Plates. Edward Halse. Considers that for a certain class of ore electro-silvered plates catch more gold in proportion than the plain copper plates working under similar conditions, but that such gold is of an increased fineness. 1500 w. Eng & Min Jour—Feb. 16, 1901. No. 39337.

Note on Cheap Gold-Milling in Mexico. Henry F. Collins. Describes the ore-body, the mining and milling, giving cost. 1000 w. Trans of the Am Inst of Min Engs—Feb., 1901. No. 39227 C.

Gold Mining.

Important Mining Development at the Great Barrier Island. From the *Auckland Star.* Describes the Barrier Reefs mine, and the reduction plant. 2200 w. N. Z. Mines Rec—Dec. 17, 1900. No. 39354 B.

Idaho.

Buffalo Hump, Idaho. D. G. Doubleday. Facts about a gold mining region which is attracting great attention and promises well. Ill. 2200 w. Mines & Min—Feb., 1901. No. 39123 C.

Melting Point.

On the Melting Point of Gold. Ludwig Holborn and Arthur L. Day. Describes experimental investigations. 1200 w. Am Jour of Sci—Feb., 1901. No. 39188 D.

Refining.

Description of an Improved Apparatus or Method of Desilverizing Base Bullion. Stephen Tredinnick. Illustrates and describes the writer's series apparatus and its working, comparing with other processes. 3000 w. W Min Wld—Feb. 9, 1901. No. 39242.

Sludges.

Extraction of Gold From Sludges. From the *Queensland Government Mining Journal.* Particulars regarding a method of successful cyanide treatment. 900 w. N. Z. Mines Rec—Dec. 17, 1901. No. 39356 B.

Tailings.

Cyaniding Stamp Mill Tailings in Western America. William Magenau. A description of the Dexter Gold Mining Company's plant at Tuscarora, Nevada. 3300 w. Mines & Min—Feb., 1901. No. 39124 C.

IRON AND STEEL.

Blast Furnaces.

New Blast Furnace at Couillet (Belgium). Illustrated description. The special feature consists in the shaft being entirely independent of the mouth and the closing and charging appliances. 2000 w. Col Guard—Jan. 25, 1901. No. 39167 A.

France.

Influence of the Exposition on the French Iron and Steel Industry. Henri Guérin. A review of the successive developments which have followed the various expositions, and a review of the present status of the iron and steel industries of France. 3500 w. Engineering Magazine—March, 1901. No. 39474 B.

Furnace Gas.

See Gas Engineering.

Hardening.

Preparation of Steel, and Points on Hardening. E. R. Markham. On the treatment of tool steel. 1600 w. Loc Engng—Feb., 1901. No. 39111 C.

Iron Trade.

Lake Superior Iron Trade During 1900. Dwight E. Woodbridge. Concerning the output and growth of the industry, the ore reserves, and the conditions of ownership and transportation. 3500 w. Mines & Min—Feb., 1901. No. 39126 C.

Russia.

The Iron and Steel Industries of the Urals. G. Kamensky. A review of this industry, the output and methods. The pig-iron is smelted exclusively on charcoal fuel. 1400 w. Ir & Coal Trds Rev—Feb. 1, 1901. No. 39279 A.

Steel Trust.

The Great Consolidation. Concerning a movement to place practically the whole of the steel trade of the Central West in the United States, under one control. 4800 w. Ir Age—Feb. 14, 1901. No. 39255.

The Great Consolidation. Discusses the basis of exchange of securities, fixed charges, advantages claimed, outside interests, prices, etc. 3800 w. Ir Age—Feb. 28, 1901. No. 39537.

The Giant Steel Trust. Editorial discussion of the recent combination of large steel producers in America. 1800 w. Engr, Lond—Feb. 15, 1901. No. 39523 A.

The Great Steel Trust. Editorial discussion of the combination of the steel industries in America, and the outlook. 2200 w. Engng—Feb. 15, 1901. No. 39519 A.

The United States Steel Corporation. Text of the articles of incorporation filed with the State Department of New Jersey on Feb. 25, 1901. 2500 w. Ir Age—Feb. 28, 1901. No. 39536.

Tempering.

On the Tempering of Iron Hardened by Overstrain. James Muir. Abstract of a paper communicated by Prof. Ewing, read before the Royal Soc. The work described is a continuation of that described in a paper by the present author, "On the Recovery of Iron From Overstrain." 1500 w. Engng—Jan. 25, 1901. No. 39165 A.

MINING.

Arizona.

The Geology and Vein-Phenomena of Arizona. Dr. Theo. B. Comstock. Describes the structural geology and mineral belts, the vein structure, and disturbances, reviewing the stratigraphy and its economic relations. 24000 w. Trans Am Inst of Min Engs—Aug., 1900. No. 39222 D.

Exploration.

The Diamond Drill in Exploration Work. Dr. Emil E. Lungwitz. Discusses the conditions favorable to the use of these drills, and the results. 1500 w. Min Jour—Jan. 26, 1901. Serial. 1st part. No. 39269 A.

Explosives.

Explosives Used in Metal Mining Harold Harris. Read before the N. S. W. Chamber of Mines. A brief description of the nitroglycerine mixtures, with remarks on their manufacture and uses in mining. 3200 w. Aust Min Stand—Jan. 10, 1901. No. 39358 B.

Foremen.

Coal Mine Foremen and Labor-Saving Devices. L. C. Morganroth. Discusses the duties of the foreman, and some of the devices in use in different mines. 2000 w. Eng & Min Jour—Feb. 16, 1901. No. 39335.

India.

Metalliferous Mining in India. John W. Evans. Concerning Peninsular India only, its geology and ores, methods of working, etc. Does not deal with the iron deposits, but briefly considers the copper, lead, silver, zinc, tin, etc., and more fully the deposits and mining of gold. General discussion. 20900 w. Jour Soc of Arts—Feb. 1, 1901. No. 39271 A.

Instruments.

See Civil Engineering, Measurement.

Mine Maps.

When in Black and White. Claude V. Martin. Read before the Ohio Inst. of Min. Engs. Some suggestions in regard to the attainment of a neat and clear appearance in the making of mine maps. 1500 w. Mines & Min—Feb., 1901. No. 39125 C.

Mining Plant.

See Electrical Engineering, Power.

Pumping.

The Pumping Machinery of the Bruch Colliery (Wasserwirthschaft der Gewerkschaft Brucher Kohlenwerke). A. Padour. Illustrated description of horizontal, underground pumping machinery in the colliery at Bruch, in northwestern Bohemia. 3500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 9, 1901. No. 39450 B.

Shaft-Sinking.

Difficulties in Congelation for Sinking and Deepening an Abandoned Shaft. An illustrated account of the difficulties and the means of overcoming them. 2800 w. Col Guard—Jan. 25, 1901. No. 39168 A.

The Deep Sinking of Shafts at the Sydney Harbor Colliery. Interesting particulars concerning the work, with illustrations. 4400 w. Col Guard—Feb. 1, 1901. No. 39284 A.

Tunnels.

The Opening of Mines by Tunnels. D. W. Brunton. An illustrated description of methods of timbering, operating, etc. 1600 w. Eng & Min Jour—Feb. 2, 1901. No. 39144.

Veins.

The Origin of Vein Cavities. Frank L. Nason. The present article considers fissure veins, discussing their peculiarities, causes, etc. 2500 w. Eng & Min Jour—Feb. 9, 1901. Serial. 1st part. No. 39267.

Volume.

A Method for Obtaining the Volume of Small Drifts and Working-Places, Where It Is Impossible to Use a Transit. Discussion of paper bv C. S. Herzig. 600 w. Trans Am Inst of Min Engs—Aug., 1900. No. 39226 C.

Winding-Ropes.

The Testing of Winding Ropes in the Province of Anhalt, Germany. Frank H. Probert. Notes on the method of testing and the results obtained. Ill. 2500 w. Trans Am Inst of Min Engs—Aug., 1900. No. 39229 D.

MISCELLANY.

Aluminum.

Aluminum at the Paris Exposition (1900). Joseph W. Richards. Remarks on the present position of the metal, and description of the exhibits. 2500 w. Jour Fr. Inst—Feb., 1901. No. 39190 D.

Diamonds.

Diamonds in Volcanic Breccia. E. F. Pittman. Describes the discovery of diamonds in the breccia taken out of a shaft on Ruby Hill in Australia, and the conclusions drawn. 1800 w. Aust Min Stand—Dec. 20, 1900. No. 39069 B

Exposition.

The Mining Exhibits at the Exposition of 1900 (L'Exploitation des Mines à l'Exposition de 1900). H. Schmerber. The first installment relates principally to the French collieries. 2500 w. Génie Civil—Feb. 2, 1901. No. 39407 D.

Korea.

Mining Conditions in Korea. Describes the country, climate and customs. 1000 w. Min & Sci Pr—Jan. 26, 1901. No. 39089.

Madagascar.

The Mineral Riches of the French Colonies—Madagascar (Les Richesses Minérales des Colonies Françaises-Madagascar). L. Pelatan. A general review of the geology of the island, showing the presence of gold and other metals, as well as coal. 7500 w. Rev Univ des Mines—Dec., 1900. No. 39415 F.

Nitrate of Soda.

The Nitrate of Soda Industry. Illustrates and describes the nitrate beds in Chile, and the methods employed in opening them and preparing the product for the market. 1100 w. Eng & Min Jour—Feb. 23, 1901. No. 39395.

Ore Deposits.

The Secondary Enrichment of Ore-Deposits. Arthur L. Collins. Discussion of the papers of Messrs. Emmons and Weed. 700 w. Trans Am Inst of Min Engs—Feb., 1901. No. 39225 C.

Petroleum.

On the Classification of Crude Petroleums. S. F. Peckham. Read at the Congress in Paris and revised for publication. An account of researches made in this field, with suggestions for a system of classification. 3500 w. Jour Fr Inst—Feb., 1901. No. 39191 D.

Petroleum in California. From the *Oil, Paint and Drug Reporter*. Reviews the history of the development of these deposits, and the present outlook. 1800 w. Pro Age—Feb. 15, 1901. No. 39345.

Petroleum Indications at Deep Creek, Lake Brunner. Alexander McKay. Report of the government geologist concerning the indications of oil found, with description of the geology of the district, and other information. 1800 w. N. Z. Mines Rec—Dec. 17, 1900. No. 39352 B.

The Beaumont Oil Field, Texas. William B. Phillips. General information in regard to this great oil producer, recently discovered. Ill. 2800 w. Eng & Min Jour—Feb. 9, 1901. No. 39266.

Russia.

The Russian Coal and Pig Iron Industry (Die Russische Kohlen und Roheisen Industrie). Dr. Neumark. Especially discussing the products of southern Russia, with tabulated statistics and maps. Two articles, 7500 w. 2 plates. Stahl und Eisen—Jan. 15, Feb. 1, 1901. No. 39440 each D.

Slate.

The Slate Quarries of Angers (Notes sur les Ardoisières d'Angers). J. Kersten. A discussion of the geology of the region and an account of the working of the quarries in Anjou. 3000 w. Rev Univ des Mines—Dec., 1900. No. 39414 F.

Sulphur.

Sulphur. Edward W. Parker. Extract from the annual report of the U. S. Geol. Survey. Information relating to the amount consumed in the United States, where it is produced, and the methods of reducing the ores. 3300 w. Mines & Min—Feb., 1901. No. 39122 C.

Tin.

The Greenbushes Tinfields (W. A.) Describes a deposit in southwest Australia, and also the smelting works. 2000 w. Aust Min Stand—Dec. 20, 1900. No. 39070 B.

Utah.

A New Mining Region. Don Maguire. An account of a new locality for mining, comprising the greater part of Box Elder county. The ores are gold, silver, copper, lead, zinc, antimony, iron, nickel, cobalt, etc. Also illustrations showing the difficulties met in constructing the aerial tramway. 2000 w. Min & Sci Pr—Feb. 16, 1901. No. 39500.

RAILWAYS AND TRAMWAYS

CONDUCTING TRANSPORTATION.

Accidents.

An Accident at Offenbach, Germany. Official translation of a report of the officers of the Prussian State Railroad Administration concerning an accident that caused loss of life. 1300 w. R R Gaz—Feb. 8, 1901. No. 39213.

Train Accidents in 1900. A tabulated

statement of train accidents for 28 years, their nature and cause; also of casualties to passengers and employees during 1900, with remarks on the accidents. 1500 w. R R Gaz—Feb. 15, 1901. No. 39301.

Train Accidents in the United States in December. Detailed list and classified summary for the month. 3000 w. R R Gaz—Feb. 1, 1901. No. 39117.

Education.

The Education of Railroad Men for Subordinate Positions of Responsibility. Walter S. Berg. Address before the Convention at St. Louis. Deals particularly with reference to employees of the bridge and building department of railroads. 7300 w. Pro. of Assn. of Ry Supts of Bdgs & Bldgs—Oct., 1900. No. 39159 D.

European Railways.

European Railway Jottings. Charles Rous-Marten. Notes on British train service during the last year of the century. 1600 w. Loc Engng—Feb., 1901. No. 39112 C.

Fast Trains.

The Speed of Express Trains in Europe. Editorial on an article in the *Archiv für Eisenbahnwesen,* by W. Schulze, making a study of this subject. 1100 w. R R Gaz—Feb. 8, 1901. No. 39214.

Paris.

The Improvement in Local Transport in Paris (Amélioration des Transports en Commun à Paris). Marcel Delmas. A discussion of the present inadequate methods, with suggestions for improvement. 10000 w. Soc Ing Civ de France—Dec., 1900. No. 39428 G.

Rating.

A New Method of Rating and Loading Engines in Freight Service. Thomas Tait. An explanation of new method adopted by the Canadian Pacific, giving tabulated information, forms of reports, etc. General discussion follows. 13000 w. N. Y. R R Club—Jan. 17, 1901. No. 39305.

Suburban Service.

A Typical Suburban Service. An account of the service rendered by the Chicago & Northwestern R. R., in carrying rural residents to and from Chicago. Map and ills. 5200 w. Ry Age—Feb. 15, 1901. No. 39332.

MOTIVE POWER AND EQUIPMENT.

Acceleration.

Acceleration of Electric Cars. George H. Morse. The bearing of this subject on the economy of the system is discussed, the conditions to be met and the best practice. 1700 w. St Ry Jour—Feb. 2, 1901. No. 39156 D.

Accumulators.

The Accumulator as a Source of Economy in Electric Traction. W. H. Booth. Gives approximate estimates of saving and cost, and arguments favoring their use. 2400 w. Elec Rev, Lond—Jan. 25, 1901. No. 39161 A.

Air Brakes.

Air Brake Repairs. A letter from Godfrey W. Rhodes on the neglect and consequent delay of freight. 1800 w. Ry Mas Mech—Feb., 1901. No. 39240.

Increased Efficiency in Air-Brake System. Communications and discussion of this subject at January meeting. 13500 w. Cent Ry Club—Jan., 1901. No. 39328 C.

Cars.

Composite Hopper Coal Cars 100,000 Pounds Capacity. Illustrated description of cars with steel frames and wooden hoppers, built for the Norfolk & Western Ry. 1800 w. Am Engr & R R Jour—Feb., 1901. No. 39059 C.

70,000-lb. Capacity Box Cars for the Northern Pacific Ry. Plans for a 36-ft. car are given, with description. A lot of 2,750 are in process of construction. 900 w. Ry & Engng Rev—Feb. 23, 1901. No. 39396.

Structural Steel Hopper-Bottom Car of the American Car & Foundry Company. Illustrated description of an 88,000 lbs. capacity steel car. 700 w. R R Gaz—Feb. 8, 1901. No. 39212.

The "Handy" Car. Illustrated description of a new combination car, with new features in the construction of the sides and ends of the box. 900 w. R R Gaz—Feb. 1, 1901. No. 39116.

Chicago.

The South Side Overhead Electric Railway of Chicago. Illustrated description of the power-station, which furnishes power for Sprague multiple-unit system. 2500 w. Trans & Ry Wld—Jan. 10, 1901. No. 39103 A.

Couplings.

Railway Couplings. Tabulated report showing strength of standard wagon couplings, as ascertained by experiments in the testing machine at University College, Cardiff, with an account of the work. Ill. 1200 w. Engng—Feb. 15, 1901. No. 39516 A.

Exposition.

The Central Railway of France (Compagnie des Chemins de Fer du Midi). A review of the exhibits of this company, including rolling stock, tools, etc. 20000 w. 6 plates. Rev Gen d Chemins de Fer—Jan., 1901. No. 39430 H.

The General Omnibus Company (La Compagnie Générale des Omnibus). A review of the exhibits of the Paris Company, including motor cars propelled by compressed air, electric accumulators, and steam. 8000 w. Rev Gen d Chemins d Fer—Jan., 1901. No. 39431 H.

Ganz System.

The Ganz System of Electric Traction. Describes an experimental road constructed on this system, and manner of working. 4400 w. Engr, Lond—Feb. 1, 1901. No. 39283 A.

The Ganz System of Electric Traction. Further information of this system, concerning the use made of compressed air, the safety appliances, the equipment, a comparison of costs, etc. 4500 w. Engr, Lond—Feb. 15, 1901. No. 39522 A.

Hot Boxes.

Hot Driving Boxes on Locomotives. M. E. Wells. Emphasizes the importance of care in packing, and discusses the kind of boxes, oil holes, etc. General discussion. 9000 w. W Ry Club—Jan., 1901. No. 39304 C.

Jungfrau.

Electric Locomotive No. 4 for the Jungfrau Railway (Die Elektrische Ausrüstung der Jungfraubahn lokomotive No. 4). Giving photographs of the motors and machinery; also diagrams of the wiring and charts of the performance. 3000 w. Schweizerische Bauzeitung—Feb. 2, 1901. No. 39452 B.

The Jungfrau Polyphase Electric Railway. Illustrates and describes some details of the electrical equipment. 1500 w. Elec Rev, N. Y.—Feb. 2, 1901. No. 39139.

Locomotives.

"Central Atlantic" Type Passenger Locomotive. Illustrated description of a large capacity engine with traction increaser attachment, built for the N. Y. C. & H. R. R. R. 1600 w. Am Engr & R R Jour—Feb., 1901. No. 39057 C.

Compound "Atlantic" Type Passenger Locomotive. Illustration, drawings and general dimensions of a wide-firebox engine for burning soft coal, built for the B. & O. Ry. 400 w. Am Engr & R R Jour—Feb., 1901. No. 39060 C.

Four-Wheel Coupled Locomotive for the Dutch States Railways. Illustration and dimensions of engine for heavy and fast mail service. 400 w. Engng—Feb. 1, 1901. No. 39288 A.

German Locomotives at the Exposition (Les Locomotives Allemandes à l'Exposition). D. Bellet. The first installment of a serial review of the engines exhibited by German makers at Vincennes. Serial, Part I. 2500 w. Revue Technique—Jan. 25, 1901. No. 39411 D.

Heavy 10-Wheel Compound Passenger Locomotive. Brief illustrated description of one of twenty engines built for the Union Pacific Ry., the heaviest of their type ever built. 350 w. Am Engr & R R Jour—Feb., 1901. No. 39062 C.

Locomotive Classification on the Pennsylvania. An explanation of the classification now used. 600 w. R R Gaz—Feb. 1, 1901. No. 39115.

Locomotives at the Exposition of 1900 (Les Locomotives à l'Exposition de 1900). F. Barbier. Illustrating and describing the compound express locomotives of the North Eastern and the Central Railways of Switzerland. 1200 w. 1 plate. Génie Civil—Feb. 2, 1901. No. 39406 D.

Locomotives at the Paris Exposition of 1900 (Exposition Universelle de Paris, 1900, Les Locomotives). A. Stevart. A comprehensive review by the honorary Chief Engineer of the Belgian State Railways. Serial, Part I. 5000 w. Rev Univ des Mines—Jan., 1901. No. 39416 F.

Strength and Weakness of Compound Locomotives. C. R. Petrie. States some facts brought out by the use of compounds. 600 w. Loc Engng—Feb., 1901. No. 39110 C.

The Actual Working of American Locomotives on British Railways. C. Rous-Marten. Showing the satisfactory service both in England and in British colonies, with much authentic information as to actual conditions and performances. 4500 w. Engineering Magazine—March, 1901. No. 39475 B.

The Hungarian Locomotives at the Exposition of 1900 (Les Locomotives Hongroises à l'Exposition de 1900). R. Godfernaux. Illustrated description of the three Hungarian locomotives exhibited at Vincennes. 2500 w. 1 plate. Rev Gen d Chemins de Fer—Jan., 1901. No. 39432 H.

The Locomotive. Brief illustrated outline of the changes which have led to the locomotive of the present. 2200 w. Engr, U. S. A.—Jan. 15, 1901. No. 39077.

The New Class I. Central-Atlantic Type Locomotives—New York Central Railroad. Concerning the new classification of engines on this road, with illustrated description of the new type which will pull the Empire State Express. 1800 w. R R Gaz—Feb. 1, 1901. No. 39114.

Vanderbilt Locomotive Boiler. An illustrated description of one of the two consolidation locomotives used on the B. & O. R. R., with remarks on the distinctive features. 1000 w. Sci Am—Feb. 16, 1901. No. 39293.

Motive Power.

The Glasgow Electric Tramways Engines. The engines for this project were divided between English and American makers. This article describes the two English built engines. 1500 w. Engng—Feb. 1, 1901. No. 39287 A.

Motors.

The Efficiency of Street Railway Motors (Zur Frage der Leistungsbezeichnung von Strassenbahnmotoren). M. Müller. An examination of the conditions of action of motors in tramway service, with a view to proper powering. 3000 w. Elektrotech Zeitschr—Jan. 24, 1901. No. 39455 B.

The Control of Tramway Motors. K. Sieber, in *Elektrotechnische Zeitschrift*. Considers the advantages and disadvantages of the several systems of connection. Ill. 2500 w. Elec Engr, Lond—Jan. 25, 1901. No. 39162 A.

Sanitation.

Passenger Coach Sanitation. J. N. Hurty. From a paper read before the International Assn. of Ry. Surgeons. Suggestions for construction, ventilation, cleanliness, disinfection, etc., especially of Pullman coaches, sleeping cars, and dining cars. 2200 w. Am Engr & R R Jour—Feb., 1901. No. 39063 C.

Snow Plows.

The Use of Snow Plows and Flangers. Illustrates and describes appliances used by different railways for keeping the line open, or clearing it when blockaded by snow. 1200 w. Eng News—Jan. 31, 1901. No. 39095.

Supplies.

The Department of Tests on a Railroad. Extracts from a paper by H. B. Hodges, read before the New England R. R. Club. On the desirability of railroads maintaining their own laboratory and a system of inspection and tests of supplies purchased, giving an account of the practice of the Long Island R. R. 3800 w. R R Gaz—Feb. 15, 1901. No. 39302.

Tests.

Draft-Rigging Tests on the Atchison, Topeka & Santa Fe. Interesting information of road tests, subjecting trains to extraordinary shocks without damage to the draft-riggings or the trains. Also editorial. 2600 w. R R Gaz—Feb. 22, 1901. No. 39503.

Third Rail.

Murphy Third Rail in the Baltimore Belt Line Tunnel. States the situation of the tunnel and the arrangement for hauling traffic through it, and gives an illustrated description of the new system installed. 1500 w. Ry & Engng Rev—Feb. 2, 1901. No. 39153.

The Completion of the Albany and Hudson Third Rail Electric Railway. Illustrated detailed description of the power house, and the polyphase equipment, wiring, switchboards, sub-stations, etc. 5600 w. St Ry Jour—Feb. 2, 1901. No. 39154 D.

Tools.

Hydrostatic Tools in Railway Service. George L. Gillon. An illustrated article concerning the designs and operation of hydraulic shop jacks, wrecking jacks, transfer jacks, crank pin presses, car wheel presses, punches, rail benders, etc. Also general discussion. 12800 w. W Ry Club—Jan., 1901. No. 39303 C.

Train Heating.

Heating Passenger Trains with Exhaust Steam From the Air Pump. Illustrates and describes a system of heating used for the past two winters by the Maine Central R. R. 900 w. R R Gaz—Feb. 22, 1901. No. 39502.

Truck.

Steel Frame Passenger Truck. Brief illustrated description of a recent design for the Chemin de Fer du Nord, with springs over journal boxes. 400 w. Am Engr & R R Jour—Feb., 1901. No. 39061 C.

Underground.

Inner Circle London Underground Railway. Gives the principal points in a scheme for the electrical equipment of this road which is now operated by steam. 1000 w. Elec Wld & Engr—Feb. 2, 1901. No. 39141.

Underground Railway Construction in London. W. H. Booth. Describes the natural conditions existing, the construction, etc., criticising the methods of working, lack of proper ventilation, and faults of management. 1700 w. St Ry Jour—Feb. 2, 1901. No. 39157 D.

Wheels.

Notes on Truck Wheels. Sam Steele. Information concerning the manufacture and wear of steel-tired wheels. 1300 w. Loc Engng—Feb., 1901. No. 39108 C.

NEW PROJECTS.

Tennessee.

The Tennessee Central Railway. Illustrates and describes some of the peculiar and difficult features in construction owing to the character of the country through which the road passes. 1000 w. Engr, Lond—Jan. 25, 1901. No. 39171 A.

PERMANENT WAY AND FIXTURES.

Boston.

Unique Elevated-Underground Street Railway in Boston. J. A. Stewart. Illustrated description of interesting features of changed plans. 1200 w. Sci Am—Feb. 2, 1901. No. 39097.

Boston Subway.

Construction of the East Boston Subway and Tunnel. An illustrated description of an extension now being constructed to the underground system of rapid transit. 2000 w. Ry & Engng Rev—Feb. 16, 1901. No. 39347.

Contact System.

The Schuckert Contact System. Illustrated description of the surface contact system of electric traction which has been tried in Munich. 2200 w. Tram & Ry Wld—Jan. 10, 1901. No. 39104 A.

Denver.

Notes on the Denver City Tramway. Illustrates and describes the track and special work, the despatching system, cars, and matters of interest in the operation and management. 6000 w. St Ry Jour—Feb. 2, 1901. No. 39155 D.

Electrolysis.

Electrolysis in the District of Columbia. Grahame H. Powell. Concerning the steps being taken to provide more stringent penalties for failure to furnish a proper metallic return for the powerful currents. Information from the report of the Commissioners of the District. 2000 w. Elec Wld & Engr—Feb. 16, 1901. No. 39324.

Huddersfield.

Huddersfield Electric Tramways. Historical account and illustrated description of this English tramway and its equipment. 8400 w. Elec Engr, Lond—Feb. 15, 1901. No. 39526 A.

Hudson River R. R.

The Hudson River Railroad. Herbert T. Walker. Reviews the interesting early history of this road, and gives an illustrated description of the "Croton," one of the early locomotives. 1500 w. R R Gaz—Feb. 15, 1901. No. 39300.

Rails.

Specifications for Steel Rails. W. R. Webster. Gives the proposed standard specifications for steel rails, recommended by the American Branch of Committee No. 1 of the International Assn. for Testing Materials, and submitted for discussion, with remarks. 2500 w. Trans Am Inst of Min Engs—Feb., 1901. No. 39-224 D.

Roadbed.

Some Interesting Roadbed Construction. Brief description of work on the London & Southwestern Ry. in widening its roadbed for a four-track line. 500 w. Ry & Engng Rec—Feb. 16, 1901. No. 39346.

Shops.

New Car Shops. Illustrates and describes a new plant for the N. Y., N. H. & H. R. R., at Readville, Mass., used exclusively for cars and having electric distribution of power. 1100 w. Am Engr & R R Jour—Feb., 1901. No. 39058 C.

Readville Car Shops—New York, New Haven & Hartford. General plan of shops being built at Readville, Mass., which will probably be the most extensive plant in the United States. Description. 1700 w. R R Gaz—Feb. 15, 1901. No. 39299.

Readville Car Shops—New York, New Haven & Hartford R. R. Illustrated article on the arrangement of tools and machinery of the blacksmith and machine shops. 1200 w. R R Gaz—Feb. 22, 1901. No. 39504.

South-Eastern Railway Works. An account of the new works of South-Eastern and Chatham Ry. Co. 1500 w. Engr, Lond—Feb. 8, 1901. No. 39372 A.

Signals.

The New Manual Interlocking Machine. Illustrated description of a machine designed on the usual system of preliminary locking, but with the locking mechanism connected directly to the rockers. The invention of Benton C. Rowell. 1100 w. Eng News—Jan. 31, 1901. No. 39091.

Steep Railways.

The Steepest Railways in the United States. Waldon Fawcett. Illustrated descriptions of the Mt. Washington Rack Railway, and the Pike's Rack Railway. 1600 w. Sci Am—Feb. 2, 1901. No. 39098.

Suburban.

Lewiston-Brunswick & Bath Street Railway. Illustrated description of interesting line in Maine, furnishing communication between villages and cities, and comprising 55 miles of track. 2400 w. St Ry Rev—Feb. 15, 1901. No. 39327 C.

Terminal.

Some Engineering Features of the Grand Central Station, New York. Illustrated description of the electric lighting, hydraulic elevator, air compressing, ventilating and heating equipment. 3500 w. Eng Rec—Feb. 23, 1901. No. 39392.

Track.

Methods of Laying Track (Pose de la Voie). H. Seymat. A comparison of the various methods of constructing the permanent way of railways at present in use. 5000 w. Soc Ing Civ de France—Dec., 1900. No. 39427 G.

Widening.

Widening the South-Western Railway. An account of the important work on the different sections, which will provide the London and South-Western Ry. with four tracks from Waterloo to Worting Junction. 2300 w. Engr, Lond—Feb. 8, 1901. No. 39373 A.

MISCELLANY.

Statistics.

Statistics of Electric Tramways in Germany (Statistik der Elektrischen Bahnen in Deutschland). The annual review giving tabulated details concerning roads in operation, under construction and projected. 12000 w. Elektrotech Zeitschr—Feb. 7, 1901. No. 39464 B.

CURRENT RECORD OF NEW BOOKS

The Book Department of THE ENGINEERING MAGAZINE *is prepared to supply any work here mentioned, at the Publisher's price, delivered post paid to any part of the world. Checks. Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE. *These pages are issued separately from the Magazine, printed on one side of the paper only, for card index purposes in libraries. See introductory to "The Engineering Index."*

Lighting.

Electric Lighting. A Practical Exposition of the Art. Volume II. Distributing System and Lamps. By Francis B. Crocker, E. M., Ph. D. Price $3.00. Size 6 in. by 9 in. pp. 505. New York: D. Van Nostrand Co. London: E. & F. N. Spon.

The second volume of Professor Crocker's gives us probably the most complete and modern discussion of electrical distribution, transformation, and wiring yet published, as well as an account of arc and incandescent lamps, and electric meters. The latest revision of the National Electric Code, and the Report of the Committee on Standardization of the American Institute of Electrical Engineers are given as appendices.

Municipal Works.

Municipal Public Works. An Elementary Manual of Municipal Engineering. By Ernest M'Cullough, C. E. Price 50 cents. Size 6 in, by 9 in. pp. 153. Lewiston, Idaho. Published by the Author.

A convenient little handbook containing much useful general information concerning Streets, Drainage, Water Supply, Lighting, etc., in a form suitable for the use of non-professional men who may be on city committees, or in similar positions, where problems of municipal engineering come before them for consideration.

Electrical Measurement.

Mesures Electriques. Leçons Professées a l'Institut Electrotechnique Montefiore. Par Eric Gerard. Price 12 francs. Size 6 in by 10 in. pp. 524. Paris: Gauthier-Villars.

This volume is devoted entirely to the discussion of the measurement of electrical quantities, current, potential, resistance, capacity, etc., and of magnetic quantities, as permeability, hysteresis, etc. A chapter is devoted to standards of measurement, and one to photometry, and the subject of commercial electricity meters is briefly considered.

Copper.

The Copper Handbook. By Horace J. Stevens. Price $1.00. Size 6 in. by 9 in. pp. 314. Houghton, Michigan. Published by the Author.

A very full collection of statistics relating to the copper production, values, consumption, and exports of the United States. Also Tables of the English copper trade the world's copper production, and much general information concerning copper mining, and mining companies.

Lathes.

English and American Lathes. By Joseph Horner . Price 21s. Size 10 in. by 12 in. pp. 164. London: Whitaker & Co.

A comparative study of lathe construction in England and America, with many illustrations showing the practice in both countries. Each portion of the tool is given in a separate chapter, and the national peculiarities are studied and their respective merits and disadvantages noted. A chapter is devoted to turret lathes and one to special lathes.

Calculus.

Elementary Illustrations of the Differential and Integral Calculus. By Augustus De Morgan. Price $1.00. 5s. Size 5½ in. by 7½ in. pp. 144. Chicago: The Open Court Publishing Co.. London: Kegan Paul, Trench, Trubner & Co., Limited.

A reprint of Professor De Morgan's well-known work, long since out of print, and dealing with the fundamental principles of the calculus in a manner which clears away many of the difficulties of the subject. A brief bibliography of English, French, and German textbooks on the calculus is appended.

Mathematics.

Mathematical Essays and Recreations. By Hermann Schubert. Translated from the German by Thomas J. McCormack. Price 75 cents. 3s. 6d. Size 6 in. by 9 in. pp. 149. Chicago: The Open Court Publishing Company. London: Kegan Paul, Trench, Trubner & Co., Limited.

A collection of general essays upon mathematical subjects, including the fourth dimension, history of attempts to square the circle, the nature of mathematical knowledge, etc., etc. Professor Schubert's writings have attracted much attention in Germany, and this enables English readers to enjoy and profit by them.

Engineering Education.

Society for the Promotion of Engineering Education. Proceedings of the Eighth Annual Meeting. Vol. VIII. Edited by John B. Johnson, Albert Kingsbury, Henry S. Jacoby. Price $2.50. Size 6 in. by 9 in. pp. 376. New York: Engineering News Publishing Co.

Full report of the meeting held in New York in July last, giving the complete text of papers and discussions. The subjects cover the general theory of industrial education, engineering education in specialized branches, the attitude of technical schools toward commercial and manufacturing aspects of applied science, laboratory work, manual training, teaching methods, and the relations of the instructor. Appendices give the membership, officers and constitution of the Society. Indexed.

Cement.

The Cement Industry. Description of Portland and National Cement Plants in the United States and Europe, with Notes on materials and Processes in Portland Cement Manufacture. Reprinted from *The Engineering Record.* Fully illustrated. Price $3.00. Size 6 in. by 9 in. pp. 235. New York: The Engineering Record.

A series of reprinted illustrated articles. The first, by S. B. Newbery, is a general review of the Portland Cement process. The next eighteen, by various authors, are descriptive of individual American plants; the twentieth deals with the rotary-kiln process; the last three devoted to plants in England and Belgium, Germany and France.

Railway Equipment.

Proceedings of the Western Railway Club. Official Report. Vol. XI. Club Year of 1898-9. 6 in. by 9 in. pp. 416. Vol. XII, Club Year 1899-1900. 6 in. by 9 in. pp. 429. Published by the Western Railway Club, Chicago, Ill., U. S. A.

A full transcript of the proceedings, including addresses, committee reports, papers and discussions. The matters belong almost entirely to the maintenance of equipment department, covering both the mechanical and the transportation problems faced by the master mechanic and master car builder. The discussions are very fully reported and each volume is indexed.

Strength of Materials.

Résistance des Matériaux et Eléments de la Théorie Mathématique de l'Elasticité. By Augustus Föppl. Translated from the German by E. Hahn. Price 15 fr. Size 6 in. by 10 in. pp. 489. Paris: Gauthier-Villars.

A French translation of Föppl's classic work, discussing the fundamental principles of the strength of materials analytically in form for study and reference by the trained engineer. The chapter containing the resume of the mathematical theory of elasticity, according to the modern researches of Boussinesq and Hertz, is especially to be noted. The principal formulas contained in the body of the work are collected as an appendix for greater convenience in practical use.

The Strength of Materials. By J. A. Ewing. Size 6 in. by 9 in. Cambridge: University Press.

A reprint, with many additions and improvements, of Professor Ewing's article on the Strength of Materials in the Ninth Edition of the Encyclopædia Britannica. The work is intended to be used as a text book in connection with drawing office and laboratory work.

Engineering Law.

The Law of Operations Preliminary to Construction in Engineering and Architecture. By John Cassan Wait. Price $5.00. Size 6 in. by 9 in. pp. 638. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Supplementing the author's previous work, "Engineering and Architectural Jurisprudence," and dealing with the knowledge of legal matters essential to the most advantageous conduct of the preliminaries of engineering work, such as rights in real property, boundaries, easements, and franchises.

Logarithms.

An Improved Table of Five-Figure Logarithms. By E. Erskine Scott. Size 4½ in. by 8 in. pp. 66. London: Charles and Edward Layton.

A very convenient small table of five-figure logarithms, especially to be noticed for the arrangement for taking out the differences, these being entered in the table so as to avoid unnecessary computation. The typography has been chosen with especial reference to clearness, and a judicious spacing between the columns also tends to diminish the fatigue of the eyes.

Liquefaction.

The Rise and Development of the Liquefaction of Gases. By Willett L. Hardin, Ph. D. Price, $1.50. Size 5 in. by 7 in. pp. 244. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

A complete history of the development of the methods employed in the liquefaction of gases, with references to the original memoirs of the various investigators.

THE WORLD IS ITS FIELD.

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BRITAIN AND HER COMPETITORS IN IRON AND STEEL MAKING.

By E. Phillips.

Since this article was written, the most gigantic trust ever known has been formed in the American steel trade. The physical conditions of production reviewed by Mr. Phillips, however, are unchanged, except that specialisation and intensification have yet larger scope. Whether this Titanic system can be co-ordinated and unified—whether the enormous requisite dividends can be earned—remains to be seen. But one thing is certain. Industrial expansion is dependent on cheap steel. The nation which fails to secure it—fails by tolerance either of false political economy or of commercial blindness—will lose its ascendancy.—THE EDITORS.

CONSIDERATION of the question of the present conditions and future tendencies of the iron and steel industry is of far-reaching and vital importance to the future of Britain and of those engaged in her engineering works; so much so that if Britain is to continue to retain a goodly share of the world's orders, and to maintain her hitherto national position as the leading manufacturing "workshop" of the world, she must at once wake up and ascertain the causes which have brought about the recent competition in iron and steel products, not only in what in the past were Britain's exclusive markets, but also in her home orders. She must ascertain if anything can be done to meet the new conditions which threaten to overwhelm her. Less than twenty years ago Britain was a larger producer or iron and steel than any other country in the world, but during the last decade such has been the expansion and development of Germany and America (but more especially in the latter) that from the position

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of industrial supremacy, England has dropped to the third place in the production of iron and steel, as the following statistics prove:

PIG-IRON PRODUCTION.

In 1889 Britain made	8,322,824 tons.	America made	7,603,642
In 1899 Britain made	9,000,000 tons.	America made	13,620,703
Increase	677,176 tons.		6,018,061

STEEL PRODUCTION.

In 1890 Britain made	3,679,043	Germany	2,239,099	America	4,277,071
In 1899 Britain made	4,855,325	Germany	6,250,000	America	10,639,857
Increase	1,176,272		4,010,911		6,362,786

The foregoing figures show very conclusively that the increased growth of production in Germany during the last decade was nearly four times as much as that in England, whilst that of America was nearly six times greater.

In 1890 Britain exported 4,001,430 tons, but in 1899 only 3,717,180 tons; whereas the value of American exports increased from $25,542,000 in 1890 to $105,690,000 in 1899; England thus showed a decrease of nearly one-fourteenth, whilst America quadrupled her exports. The American exports of iron and steel to England in 1890 amounted to 222,776 tons. In 1899 this was increased to 333,113 tons, sufficient (with the lower rates at which they were able to deliver it) to cause a "slump" in prices, and to turn what was before a profitable industry into an unprofitable one, at the recent high prices of coal, coke, ore, and wages in England.

As further illustrating the effect of this importation on local steelmaking works, it may be mentioned that 25,750 tons of American bars were delivered at Alexandra Docks, Newport, in 1900, and 24,521 tons at Swansea and Cardiff, in all 50,271 tons for South Wales works; and when it is considered that each ton of steel represents two tons of ore, the significance of this is evident. As a result, there was a great falling off in British ore importations. The Board of Trade returns during the twelve months of 1899 shows that the amount of ore received at Newport was 611,915 tons; during the corresponding twelve months of 1900 it was only 424,700 tons, showing a decrease of 187,215 tons, chiefly due to American competition. And what applies to Newport, applies more or less equally to the northern ports of England. The consequence was that local works have only been partly employed. The Board of Trade returns of the quantity and value of iron ore imported during the years 1899 and 1900 to eleven of the principal ports of the kingdom, viz., to Barrow, Cardiff, Maryport, Middlesborough, Newcastle, Newport, South Shields, Stockton, Swansea, Ardrossan, and Glasgow, were as follows:

In 1899, ore imports......	7,054,578 tons, of the value......	£5,374,918
In 1900, ore imports......	6,297,873 tons, of the value......	6,639,003

showing a decrease in quantity of 756,705 tons, but an increase in value of £264,085. There are twenty-six other smaller ports which imported about 750,000 tons, the Board of Trade returns for which are not yet published.

It is interesting to note that in 1876 (a quarter of a century ago) the import of ore into the kingdom was only 672,236 tons; now it is about 7,000,000 tons. The out-put of iron ore raised in the kingdom in 1874 was 14,844,931 tons; in 1899 (twenty-five years later) it was only 14,461,320 tons. There have been fluctuations in the intervening years, sometimes more and sometimes less, but practically the amount raised is the same as it was twenty-five years ago; so that any increase in British make must come from imported ore. Two-thirds is now raised in the kingdom and one-third imported, but as far as South Wales is concerned it is practically all imported ore that is used.

Without being over pessimistic as to the future, it is quite evident to those who have the welfare of England at heart and see the trend of the new conditions they have to face, that very drastic remedial measures will need to be adopted; otherwise retrogression of the next decade will be much greater than that of the past. It will not do to say as some do even now, "Oh, this competition of the Americans is a mere 'flash in the pan;' they are only 'dumping' down their surplus so as to keep up prices at home, and they do it at a loss. Wait a little till ore, coal, and wages return to a more normal state, and this innovation will soon come to an end. They will get tired of sending their stuff here at a loss." But will they, or do they send it at a loss?

Up to the present only a few of the British manufacturers, and we fear none of the workmen, in the iron industries have at all realised the forces that are at work, the magnitude and enormous natural advantages and resources which the Americans possess, with their cheap ore and coal combined with their skill and enterprise, their labour-saving appliances, their low railway rates and water freightage of their ores from mines to furnaces, and the best equipped works in the world. All this places them at a great advantage, whilst England has hitherto been working according to antiquated "ding-dong" methods. The consequence is that unless she at once wakes up and adapts herself to the new requirements, her past prestige will pass away. Those manufacturers who have visited the States are quite alive to the seriousness of the situation, and they appreciate the necessity for themselves and their engineers to invent new methods, and to adopt those in operation in America, so as to reduce the cost of manufacture and bring themselves into line with the most modern adaptations, thus fitting themselves to compete in the coming race with American competition. If this is done, Britain may yet supply a fair proportion of the world's requirements of steel products, but if she fails to rise to the occasion her past industrial pre-eminence will pass away.

The abnormal state of Europe in the past two years, with the boom in prices and the consequent advance in the raw material—of ore, coal, and wages—to nearly double what it was in the more normal state, no doubt gave America the opportunity to step in; for it must be borne in mind that whilst raw materials went up in Europe, this was not so in America, their ore and coal costing no more than formerly. The inflated costs of production caused the price of tin-plate bars (and all other products) to advance from £4.0.0 to £7.10.0, whilst American bars were delivered in England at £5.5.0, notwithstanding that they had to pay 7s. 6d. per ton for railway rate from Pittsburg to Baltimore and Philadelphia, the ports of shipment, and a further oversea freight of 17s. 6d. to 20s. to Britain, something like 27s. 6d. from Pittsburg furnaces to English ports. Welsh manufactureres have tried to stem this importation by reducing the price of bars to £5.0.0, which is below present cost. Americans have met this by reducing to £4.15.0, and are prepared to go lower if found necessary.

The question now comes to this: How is it possible for the American manufacturer to do this, and pay 25s. to 27s. 6d. railway rate and freight from works to Britain. Are they subsidised by Government bounties to do so? No, they are not. Do they "dump" down their products here at a loss? The reply is: No! Will the Americans be able to compete in England and the markets of the world when the prices of ore, coal, and wages come down to their more normal price? Americans say: Yes; they can. These are heart-searching questions and problems to manufacturers at the present time of industrial decline. I therefore propose giving detailed data of the comparative costs and methods in America and in Britain, commencing with the ore in the mines and proceeding to the finished steel product in the mills. I venture to think this will be an "eye-opener" to those interested in iron and steel manufacture.

American and British Costs Contrasted.—To make cheap steel, the following are esesntials. Cheap railway rates, low sea or lake freights to bring ore to furnaces, cheap coal and coke, a large output production, mechanical labour-saving appliances, and a low wage-rate cost per ton on the output, whilst paying the men good wages.

American railways are cheaply made, by reason of the land being cheap. Concessions of an extensive width of land were granted to promoters on either side of the railway, which is a valuable asset as the districts develop; the effect is that railway rates are only about one-sixth of what they are in Britain. Further, it should be borne in mind that the great steel-making firms and trusts own or are interested in the mines, the railways, and the fleet of lake steamers. The distance from Pittsburg to Conneaut Harbour, on Lake Erie, is about 155 miles. This line, known as the Pittsburg, Bessemer, & Lake Erie, is virtually Carnegie's own, so that he can fix his own rates for ore to works, and finished steel back to Lake Erie. Then again, Carnegie and his associates have their own mines, and operate very closely with J. D. Rockefeller, who controls large properties on the Lake Superior Ranges. The steel-making interests control also their own railway from the mines, known as the Duluth, Mesaba & Northern Railway Co., running from the so-called Mesaba Range to Duluth, where the ore is handled by the Bessemer S. S. Co.'s fleet, also the J. D. Rockefeller property, the most modern and up-to-date fleet of vessels on the Great Lakes. The average season rate from the head of the lakes to lower lake ports is about 2s. 6d. per ton, but Carnegie does not pay this. He and J. D. Rockefeller have long contracts at lower rates. The Federal Steel Co. are also in much the same position as the Carnegie Co.; they own and control their own mines and railway from mines to shipping port, known as the Duluth & Iron Range R. R., to shipping ports at Two Harbours; they also control a large fleet of about fifty steamers on the Great Lakes, under the name of Pickands, Mather & Co.; they have also their own coal properties, and produce large quantities, if not all, of their own coke. What the cost of ore, coke, etc., would be to an independent furnace-man and steel manufacturer (of which there are now very few, by reason of their absorption into the trusts), these companies—the Federal, Carnegie, National, Republic, and others—can reduce very considerably. Then again, the bye-product system of making coke is being introduced all over the States, resulting in a very great saving all round; that is, the sale of the bye-products and gas, either for light and heat, will give the furnace-man his coke free; furthermore, the increased capacity of the modern furnace, with large stoves and the increased blast, results in a great saving of coke in the burden of the furnaces, working as low as 1,650 pounds of coke to the (2,000 pounds) ton of pig iron.

The outcome of all this is that the Americans have no royalties to pay—no mine owners' profit, only the cost of digging out the ore—no railway dividends to pay, which is generally about one-half the earnings of the railway—no 10 to 50 per cent. dividends to ship owners, their payments being only for coal, wages, and repairs, and a moderate rate of interest on the capital outlay in the railway, mines, and steamers.

Let us now consider in detail what these extra burdens are that the British manufacturer has to pay.

Take royalties; this charge runs from 6d. to 1s. per ton on coal and ore (home raised), which, on the quantity used to make a ton of steel, amounts to 5s. per ton. Next, take the cost of Bilbao ore; in normal times he has to pay at least one-third more at Bilbao than the American ore costs delivered into boats at Lake Superior (to say nothing of having to pay last year an advance to Bilbao mine owners of 7s. per ton, and a further advance of 4s. more than formerly in freight), bringing the price, with freight, up to 21s. at ports of delivery. With tolls to works, this would be 22s. to 23s.—considerably more than double the cost of ore delivered at Pittsburg furnaces.

American Mode of Handling and Shipping Ore. The ore from Lake Superior ranges in many cases is obtained very cheaply from the mountain sides, and when dug out is loaded into twenty-five ton wagons by steam shovels, which pick up five tons at a time. The twenty-five ton wagons are loaded in two and a half minutes. The cost of the ore in many instances is not more than 1s. per ton into trucks; in other cases it has to be mined by level and by pits, which is more expensive. The cost at port of shipment in such cases may range from 2s. 6d. to 5s. per ton. Lake Superior ore contains from 60 per cent. to 65 per cent. of iron, as compared with Bilbao ore of only 50 to 55 per cent. American ore is thus 10 per cent. richer in iron than that of Bilbao or than English native ore. The ore is brought to the shipping sidings at Lake Superior. It is there sampled from the trucks and assayed before shipment. Ore containing phosphorus up to 0.045 to 0.050 per cent. is accepted by American steel manufacturers, and steel rails and bars are delivered to buyers with a maximum of phosphorus not exceeding 0.10 per cent. Their rails, bars, etc., are accepted both in America and in England on the basis of a maximum of 0.10 per cent. phosphorus and 0.10 per cent. carbon, whilst British manufacturers have to stipulate in their ore contracts that they will not receive ore containing more than 0.025 per cent. to 0.030 per cent. of phosphorus, because buyers of steel will not take delivery except it be below 0.07 per cent. of phosphorus. The basis of 0.06 per cent., with the maximum of 0.07 per cent. is the British standard; anything above is rejected. This is a very serious handicap, for there are millions of tons of Spanish ore between 0.025 per cent. and 0.05 per cent. of phosphorus, obtainable at a much less price than now paid for ore, which could be used to make steel with a maximum of 0.10 per cent. of phosphorus. How to remedy this we shall have more to say later.

Lake Superior's Shipping Facilities. To give a clear idea of this, we may say that there are several stage tips of 2,000 feet each in length, alongside of which three steamers, each carrying 5,000 to 6,000 tons can lie. These steamers are 500 to 600 feet long, with five or six self-trimming hatchways, and they can lie end to end at each stage; so there may be nine steamers loading at one at the same time at the three stages, with easy delivery to each hatchway of all the, say, nine steamers. A chute passes under the stage to the trucks on top; these trucks, of twenty-five-tons capacity each, have bottom trap-doors, by which to discharge the contents. Connected with every chute on the whole line of stages are large bins, holding from 150 to 200 tons each of ore, with trucks above over each with more ore. When the steamers come alongside, the chutes are pushed forward to the six hatches in each, the wings of the bins are opened, and about 1,000 tons is simultaneously shipped into each steamer; the trap doors of trucks are then opened to deliver contents, and additional trucks are brought over, so that in a few hours a series of boats are ready to sail the 800 to 1,000 miles to destination. Then, again, mechanical appliances are employed for quick discharge into fifty-ton trucks. Very powerful engines take thirty of these fifty-ton trucks—or a train load of 1,500 tons of ore—to Pittsburg. This rapid loading and discharge of the steamer will explain how it is the freight can be done for 2s. to 2s. 6d. per ton. Contrast this with what is done to bring ore from Bilbao to English ports, a stipulation in the charter party being that shippers shall not be required to load nor receivers at destination to discharge more than 300 to 400 tons per day. Add to this, that boats at Bilbao may have to wait days, and even weeks, for their turn at tips. All this delay has of course to be considered in the freight.

The foregoing shows how labour costs are minimised by the use of steam shovels at the mines, by trap-door self-discharging trucks, by self-delivery from the bins under stages to self-trimming steamers, by the discharging the steamers into trucks at terminal port with but little manual labour other than the superintendence and manipulation of the various mechanical arrangements, Compare this with the British and Spanish methods of loading and unloading trucks and of steamers by manual labour and hand shovelling of the ore at mines, steamers, and works. It will be apparent how mechanical appliances reduce labour costs in the manipulation of ore. Here I may say that American mines raise 17,000,000 tons annually.

Freights on the American Lakes, and from Bilbao to British Ports. The average British cargo steamer carries 2,000 tons. The American lake steamers carry 6,000 tons. The English steamer therefore has to make three trips from Bilbao to Britain to deliver as much as the lake steamer carries in one trip to port of delivery. The distance in both cases is practically the same, that from Bilbao being 1,100 miles, and that on the lakes 800 to 1,000 miles. This means that the number of men employed, the amount of coal used, the cost of repairs, insurance, etc., is three times as large to convey the 6,000 tons in English steamers as it is on the lakes.

The average freight from Bilbao over a period would be about 4s. 6d. per ton, a minimum being 3s. 9d. and a maximum 7s. 6d. The average time for a round voyage may be taken as two weeks, viz: Outward voyage three days, waiting turn for tip at Bilbao and time discharging four days, homeward voyage three days, waiting turn for berth and time discharging four days, total fourteen days. First 2,000-ton cargo, two weeks; second 2,000-ton cargo, two weeks; third 2,000-ton cargo, two weeks—making six weeks for the 6,000 tons, which the Lake steamer delivers in *one* week—the Lake steamer's time being, outward passage two days, loading one day, returning two days, and discharging two days—in all, seven days.

The *extra freight cost* to Britain is then at least 2s. 6d. per ton over lake freights. It takes two tons of ore to make one ton of steel; this means a *permanent* extra cost of 5s. per ton of steel more than is required in American practice for freight transit alone. Add to this the extra for royalties on coal, etc., amounting, as before said, to 5s. per ton of steel, and it appears that in these two items alone the British manufacturer is handicapped to the extent of 10s. per ton. It should, however, here be explained that the 5s. royalties (as before stated, in some cases it is more than 5s.) applies to British native ore, coal, coke, etc., used for manufacturing at works, and also to that consumed at ports of shipment by the engines taking ore to works and steel back for shipment, as well as to the bunker coal for steamers to convey it to foreign markets, where it has to come into competition with American steel, made unencumbered with royalty charges.

Ore Handling at Furnaces in America and Britain. At the most modern and up-to-date American furnaces, such as those at the Carnegie works, and other large steel producers, mechanical, hydraulic, and electrical labour-saving appliances which are in operation result in quick handling and great dispatch, and a less wage rate. These improved methods are to be seen in all directions. The ore is discharged at furnace stock piles from elevated railways, the trucks self-discharging the ore on to the deposits underneath by opening the bottom trap doors. Elevated, electrically-worked carriers, running on rails, collect the ore from the deposits to the pits connected with the furnaces. An inclined plane runs from the pits to the top of the furnaces—an arrangement similar to that of a "dredging machine," with an endless chain passing over pulleys at top and bottom, attached to which are the ore-charge carriers. These automatically fill themselves with the charge of ore in the pit, and an attendant in a cabin above, by touching a handle, puts the electrical arrangement in motion and the charges are moved up, another carrier at the same time coming round to fill itself; when the first carrier gets to the furnace top, the attendant touches another handle which lifts up the furnace top; by another touch, the charge is tipped in, and the furnace top shut down; the carrier returns empty, other charges being on the way up. All this is done in a few seconds, the coke and limestone being handled in the same way. Not a single person handles the ore from the pits to its delivery into furnace, other than a few men getting ready the coke and limestone for the elevator. Contrast this with the slow manual labour in the handling of ore and material at English furnaces—the shovel unloading of trucks, and the filling of the charges of ore, coke, and limestone into trams by manual labour—and the slower charging into the furnace! Snail motion, as compared with greyhound swiftness of American methods.

American Blast Furnaces. The most modern American furnaces are now made 100 feet high, with 22-feet boshes, as compared with British ones of 60 to 85 feet high with 18 to 20-foot boshes. American furnaces have numerous stoves to heat the air to a high degree, and use blast pressure up to 10, and even 15 pounds per inch to blow in this highly heated air. They have better coke, which will carry a heavier burden and costs less than British coke. They make their pig with from 16 to 18 hundredweight of coke to the ton of iron, their furnace output per day being 600 tons and latest furnaces 750 tons per day. Compare this with the English furnace output of from 100 to 250 tons per day, using 20 to 25 hundredweight of coke to the ton of pig, having fewer stoves, air less heated, with a blast pressure of only 5 pounds per inch. The result is that the production of the up-to-date furnace is *three* to *five* times greater than that of the furnaces in present use in England. This results, of course, in a much less charge per ton for staff, wage, coke, and other expenses on a 600 to 750-ton output than on the 100 to 250-ton English output. It should, however, be noted that the 750-tons output American furnace, if working Bilbao ore containing 10 per cent. less iron, could give only about 625 tons output, or one-sixth less. Then something must be said as to the mode of the cast. The old British method is to run the cast into beds; when cold, men with sledges break up and remove the pigs and prepare the bed for the next cast, which is a laborious and slow process. The Dowlais Co., at their new and in a great measure up-to-date works, on the sea-board at Cardiff, pick up the bed of pigs by an overhead travelling carrier and take it away to be mechanically broken up and put into trucks, and have there also other labour-saving arrangements. They are also about putting down the "Morgan" American merchant-bar large-output patent mill plant, with other up-to-date machinery. So are also some of the works in the North; but with these few exceptions the old methods are the rule in South Wales, the Midlands, North of England, and in Scotland, at the present time. With so large an output as 750 tons per day, it would be simply impossible for the cast to cool and the beds to be prepared in time for the next cast. Various arrangements have been adopted to carry the cast of pigs away in pig troughs as made, one arrangement being a long endless chain, on which are pig troughs set close together. These pass over a pulley under the tap holes, and are then moved upward slowly on an inclined plane, the pigs cooling on passage; as it goes over the top pulley, the pig falls into a long tank of water, a chain in the bottom of which carires it forward over another upward inclined plane; again, as it passes over the top pulley, the pig drops into the truck. The metal runs continually into the pig troughs, which move on slowly to suit the filling of each, and the lips of the one incline to the next; this arrangement is manipulated by one man working the engine that moves the endless chain with its burden of cast pigs. Not a single labour hand is needed, other than the man arranging the tapping the furnace, from the time the metal runs out of furnace till it is tipped into the truck. Just imagine what this means in the saving of labour. No worry to the furnace manager to hurry up the men to get the cast beds ready or his metal will be out of the blast openings, to say nothing as to disputes as to wages, strikes, etc.

American and British Open-Hearth Furnace Methods. The latest mechanical labour-saving triumph is that of the Wellman-Seaver electrical charging and metal-removing machine, running overhead on rails in front of the series of furnaces, with an attendant seated in his cabin on the travelling machine to manipulate it. The up-to-date American furnaces have a smelting capacity of 60 tons each, and will be all in line, one superintendent being in charge of two furnaces, and one hand for each furnace. The travelling electrical machine picks up the prepared charge of pig iron, ore, or scrap, in suitable iron boxes of 10-hundredweight each, and runs it along to the furnace mouth; the attendant pulls a handle, and the furnace door is hydraulically raised; at the same time he touches an electrical switch and the charge is pushed into the mouth of the furnace, tipped, and the charging bar withdrawn; then he lets down the furnace door. The operator then runs back the machine for another charge for the next furnace, and soon, for the series. All this is done in a few seconds of time without the help of a single hand; no men are exposed to the terrible heat in charging these great furnaces. Then, for the removal of the tapped metal, the Wellman-Seaver electrical machine is the motive power. The metal is tapped from the furnaces in 25-ton, and even 50-ton, ladles; the electrical machine, worked by the attendant in his box, picks up the 25 or 50-ton ladle, runs away with it, and discharges it into the reservoir "mixer" capable of holding 200 to 250 tons of molten metal; then he returns for another 50 tons, all being done in a few minutes. When the contents of say five furnaces have been put into the "mixer," it is tapped out of the reservoir "mixer" into the ingot molds, thus insuring the cast of all the furnaces being mixed so as to be homogeneous, which might not be the case if each furnace was run separately into ingot molds. When the ingots are just sufficiently cool to be removed, these are again similarly taken up and carried on to the re-heating furnaces in the mills, and are here charged into and removed mechanically from the re-heating furnaces to rolls, and run out into rails, plates, or other shapes. For heavy plates, etc., hydraulic power is utilised to work the roll screws; the general practice in Britain is for the roller and several men to tug away and jerk the screws round, all being in a bath of perspiration from the hot blooms and the physical labour they have to perform, whereas in the modern American mill the roller is seated in his chair aloft and there mechanically directs the entrance of the bloom into, and its return through, the rolls. By a pull of a lever he puts the hydraulic machinery in motion to set the rolls to a nicety, till the plate is rolled to the required thickness. And now comes a marvellously ingenious appliance, viz., that of an overhead electrical traveller with powerful magnets attached to chains manipulated by an attendant seated above. The chains with magnets are dropped down, and they pick up the heavy plate and run along with it to the guillotine shears. The top knife in this machine is fixed and the bottom knife is movable upwards, and by the pull of a lever the powerful hydraulic rams on either side underneath push up the knife, and the plate is instantaneously sheared. When large plates have to be cut to pattern, the attendants have simply to guide the plate suspended by the magnet to the shears. In the old-fashioned method, ten or twenty men would be needed to handle such a plate—more time occupied in doing the work, less dispatch, and much more wages cost. Another labour-saving arrangement is that designed to dispense with turning over heavy plates for inspection as to flaws and defects. The magnet carrier takes the plate over a recess room underneath the mill floor, where by electric light it is inspected from below. A further mill appliance is that of the Newbold rotary shears, capable of cutting circles, for boiler ends or other purposes, from 3-feet diameter to 11-feet diameter, and from ½ inch to 1¾ inch in thickness. When 12-feet-wide plates are rolled from which 11-feet circles are required, the useful magnet picks up the plate, after it has been cut square in the guillotine machine, and takes it to the Newbold rotary shears. The attendant places it in the powerful jaw of the machine, and the rotary cutter in the other jaw is set in motion; in two minutes the plate is cut into a perfectly true 11-feet circle; the magnet picks it up, carries it away, and piles it with others ready for delivery. Contrast this, again, with customary British methods requiring a great number of men to handle such a plate, having it chopped approximately near the circle, in the old-fashioned shears, and then carried to the mechanic in the boiler shop, who with his chisel chops it into a uniform circle; and it is at once seen what an enormous amount of manual labor, saving of time, and dispatch, are effected by the various mill equipments specified.

The mechanical equipment of the mills for a large output is such that the Illinois Steel Co. rolled out, in a day and night shift, the record quantity of 2,677 tons of rails.

Contrast, with the equipment just described, that of the British open-hearth furnace, which is usually one of only 20-tons capacity (as against the American one of 60-tons), with the proportionate extra consumption of coal to work three furnaces of 20-tons capacity, as compared with that used in the one 60-tons furnace. Four men are engaged for each furnace. The same ratio of additional labour and coal costs continues throughout the British mills.

Let us now consider what the American can make his pig iron and finished steel at, and what it costs in England with Bilbao imported ore. It works out approximately as follows, at the average normal price paid for ore, coal, and wages per ton of 2,240 pounds:

BRITAIN, WITH BILBAO ORE AT 15S. AT FURNACE.		AMERICAN ORE AT 10S. AT FURNACE.	
Ore, 2 tons 50 per cent. to 55 per cent, iron, at 15s.	£1.10.0	Ore, 65 per cent., 1¾ tons, at 10s.	£0.17.6
Coke, 1 ton 5 cwt., at 10s.	12.6	Coke, 18 cwt., at 7s. 6d.	0. 6.3
Limestone, labour, coal, repairs, etc.	7.6	Ditto	0. 6.3
	£2.10.0		£1.10.0
Conversion into rails, bars, etc.	1. 5.0	Conversion	1. 0.0
	£3.15.0		£2.10.0

From the foregoing it will be seen that the American can make his Bessemer pig at 30s. and his bar and rail at 50s., whilst at normal prices for ore, coal, and wages, the cost in Britain to make the ton of Bessemer pig is 50s., and finished rail bar 75s. In 1900 when ore was 7s. 6d. more (and is 3s. 6d. higher at present), with double price for coal, coke, and higher wages, the cost at high-water rates was probably 100s. for pigs and 130s. for rails.

At present the Americans have to pay 25s. to 27s. 6d. per ton for rail and ocean transportation from works to European ports, which added to the works cost of 50s., and say 5s., for agency expenses, etc., brings the cost delivered in Britain and the Continent to £4.0.0. The Americans are now making arrangements to reduce the present transport charge to 15s. per ton, which would bring delivery down to £3.10.0; for instead of paying 7s. 6d. for rail rate to Baltimore and Philadelphia, and 17s. 6d. to 20s. to British ships, they will load their own 2,000-ton American built steamers at Conneaut Harbour, on Lake Erie, coming through the Welland Canal (which has been deepened to 14 feet) into the St. Lawrence, thus bringing the steel direct from works by water.* Several boats have already arrived by this new route, the only drawback being that the St. Lawrence is frozen for five months of the year; for that period shipments will have to come as heretofore. There is, however, at the present time, before Congress and the legislature of New York, a great scheme of making a gigantic canal, connecting the Lakes with New York, and tide water, through which ships of largest tonnage may pass to load products from the head of Lake Superior, and steel from Lake Erie ports, whence they will sail direct to all parts of the world. If this is done, it will mean a revolution in ship-building, for the Americans will at once build their steamers on the Lakes, with their cheap steel, and before the end of the next decade will come into competition and rival Britain for the carrying trade of the ocean, supplanting her present supremacy in shipping, as they have already done as iron and steel manufacturers.

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* According to latest reports, this project has been abandoned for the present.

Summarising the leading items of extra cost to make steel in Britain with Bilbao ore, we may put it roundly as follows:

5s. per ton extra for ore at Bilbao, for 2 tons to 1 ton of steel	10s.
2s. 6d. per ton extra above lake rates for freight for 2 tons of ore	5s.
Royalties and wayleaves	5s.
Increased cost of coal, coke, increased labour charges for a less output, etc	5s.
Total, per ton of steel	£1.5.0

The British manufacturer, if he adopts all the most modern methods and appliances, and if the British workman falls into line with him by consenting to work in the various departments with the labour-saving electric and other machinery, may reduce the above extra costs by possibly 10s. But it is pretty evident that after knocking off the 10s., the American will in future still be able to make steel at 15s. per ton less than can be done in Britain with imported Bilbao ore at nominal rates; and with the contemplated reduced freights oversea, he will probably be in a position to compete even then with England in her home markets, and at 10s. to 20s. advantage in all other parts of the world.

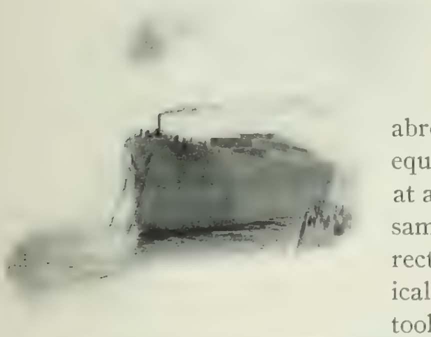
It is with great reluctance and regret that I, an Englishman, have to make the foregoing very unfavourable contrasts between British and American methods in making iron and steel, and of the dilatory progression of my countrymen in the past. I wish it were otherwise, but the facts of the case need to be fully disclosed so that when realised, every possible reform in methods ensuring rapid production with a large output may be adopted; for it will only be by doing this that Britain will be enabled to make up for her want of foresight in the past in not forecasting the looming developments in America, and to put herself in better position to fight, on more equal terms, the American competition for trade which she has now to face unprepared.

My next paper will deal specifically with the things which Britain should do to better her position in the iron and steel industry and to check the wane of her ascendancy.

THE MECHANICAL EQUIPMENT OF THE SHIP-YARD.*

By Prof. J. H. Biles.

Ship-building is of pre-eminent interest, because it is the first and greatest industry likely to be affected by a shifting of the area of cheap steel production. Many other factors, of course, enter into the problem—labour conditions, acquired experience, economic and legislative policy. And these strong physical foundations of the industry—steel and machinery for working it most advantageously—are both purchasable on approximately equal terms by all buyers. It is not likely any artificial system, either commercial or political, can keep ascendancy in ship-building from crowning those who prove themselves most fit to handle the mechanical elements of the problem, most wise to establish firmness and stability in their political and commercial economy. It is to the former of these two requirements—the mechanical elements of successful ship-building—that Professor Biles' three admirably lucid articles will be devoted.—The Editors.



IN these days of keen competition, not only at home but with foreign countries, the necessity of keeping abreast of the times in the matter of equipment is too evident to be dwelt upon at any length. Other conditions being the same, the cost of production will vary directly with the efficiency of the mechanical equipment; and modern improved tools capable of doing more work in a given time and often at less cost than the older types, together with labour-saving devices, or the substitution of mechanical for hand labour wherever possible, are essentials which will sooner or later determine the success or otherwise of an establishment such as a ship-yard.

The argument is sometimes heard in favour of old and obsolete tools, to the effect that they may have worked steadily for the last twenty years, and perhaps in their time have done good work, too, is scarcely a reason for their continued use; in fact, in many cases it is a potent argument in favour of the speedy substitution of newer and improved types. Recently, in America, new ship-building companies have been formed, which, unhampered by many old traditions, but nevertheless availing themselves of the benefit of accumulated years of experience from many countries, will have exceptional opportunities for adopting the latest and most efficient appliances for handling and working materials, and in the course of a few years will, without doubt, form powerful rivals to the old country.

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* The writer wishes to express his indebtedness to his former assistant, Prof. Sadler, and to Mr. John G. Johnstone for their assistance in the preparation of these articles.

The various tools or machines required in the mechanical equipment of a ship-yard may be roughly divided into two sections—those for handling and preparing the iron and steel work, and those for the wood work connected with a ship. The latter tools are practically the same as for any other wood-working manufactory, and beyond noticing that they must be provided in sufficient numbers in the proper place in a ship-yard equipment, they need not be further considered. A ship-joiner's shop is shown in Figure 1.

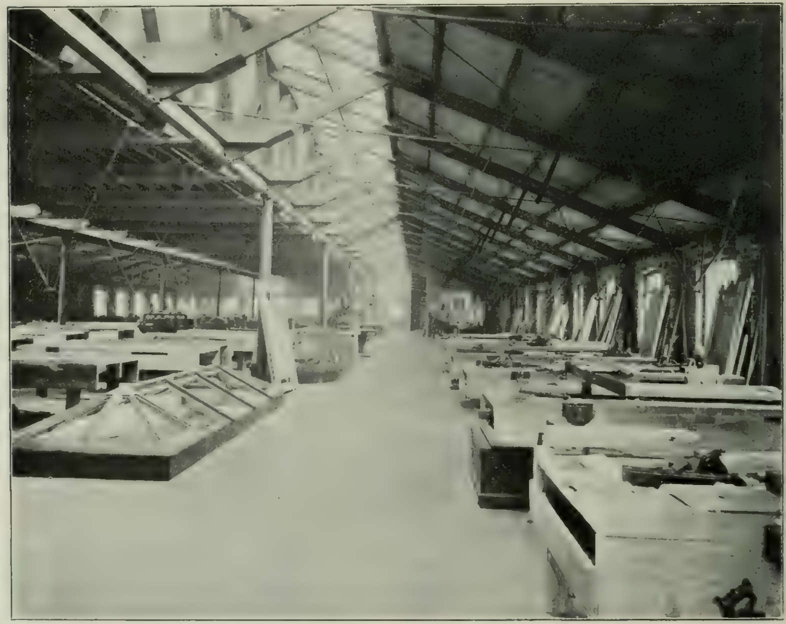


FIG. 1.—JOINER'S SHOP, C. C. SWAN & HUNTER, NEWCASTLE-ON-TYNE.

The former section of tools consists of two classes of machines:

1:—Those required in the various operations upon the material itself, such as angle bending, punching, shearing, planing, countersinking, plate-bending, plate-straightening, plate-planing, flanging, drilling, etc.;

2:—Those for assembling the various parts and for general handling of the material after it has undergone or while it is undergoing the above operations. This latter is a very important part, especially in yards and where large vessels are being built. The distance that material has to be carried during the various stages of preparation, and until it is finally in place in the vessel, has a very important bearing on the time taken to construct a vessel and hence upon the cost.

This leads to the general question of arrangement of ship-yards. Few of the larger ship-yards in the United Kingdom are arranged in the best or most efficient manner for handling material. This is largely due to the fact that from time to time additions have been made to the equipment while the general manufacturing operations were in progress, and these additions have necessarily been more or less of a makeshift order. The yard has become a patchwork of equipment instead of a complete and homogeneous design. The important point to be borne in mind in the arrangement of the ship-yard is, that the material, from its entrance to the yard until its arrival at the building berth, should be subjected to the minimum amount of handling, and that the machines or apparatus for carrying out the various stages of its preparation should be placed in the natural order of the mechanical operations thereby involved, so that when the piece is finished it should be in such a position as to be transferred to its proper place in the vessel with the minimum amount of labour. The contour and amount of ground available, and the position of the building slips, especially where these must be placed at an angle to the line of water frontage to allow sufficient room for launching in narrow waters, considerably affect the general arrangement of the yard; but in all cases machines for each section of work of the ship should be as nearly as possible grouped together. All plate-punching, shearing, edge-planing, rolling, and countersinking machines chould be collected together and arranged somewhat in the order given above, the last-named machine being as near to the building slips as possible, and the first near to the place where the material is stored on its entry to the yard. In this way, the material in the rough, while passing through the various processes to its finished state, is always tending towards its final position.

The iron work which forms the construction of the ship can be roughly divided into two sections.

1:—Framing.

2:—Plating.

1:—Framing. The equipment for making the framing of the ship is complete in itself. The framing determines the shape of the ship, and to obtain the required form full-sized moulds or shapes are necessary. These are obtained from a scrive board or floor upon which the exact form of every frame in the ship is drawn. Close to this board are the iron slabs, which form a surfacing table upon which the actual frames of the ship are bent. Adjoining this surface are the furnaces for heating the material which has to be shaped, and also for punching shearing, and bevelling machines which enable the operations other than bending to be carried out. All these items of equipment must necessarily be grouped together for convenience of doing the work and for efficiency of control. Figure 2 gives a view of the scrive board with some frames which have been bent lying upon it. To the left are seen the furnaces. In the background are the punching and shearing machines.

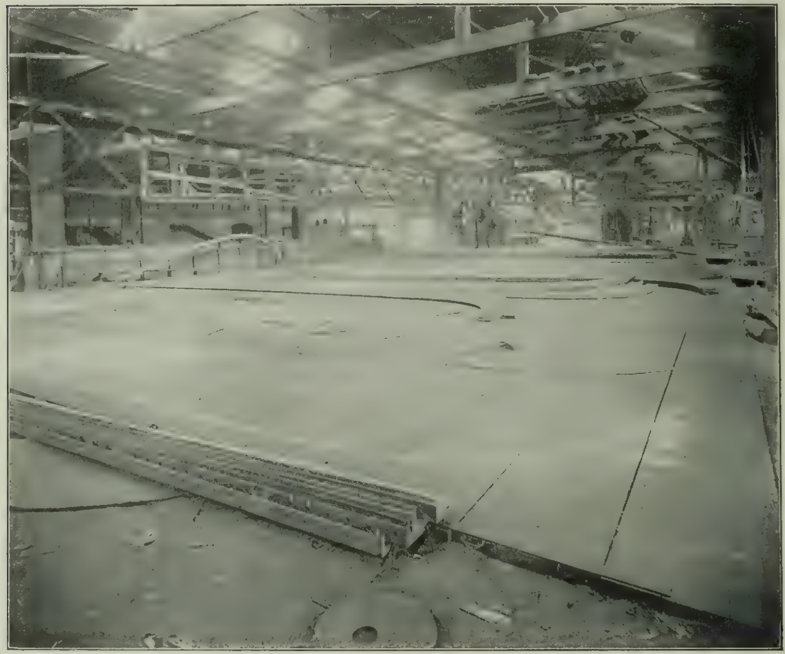


FIG. 2.—SCRIVE BOARD NEAR THE FURNACES IN A SHIP-YARD.

The lines which are put upon the scrive board are prepared in a place called the mould loft, the interior of which is shown in Figure 3. This is the place in which, after the ship's form is finally determined by the designer, the measurements of it, together with a few general particulars, are laid down. This is done to full size for breadth and depth measurements, but the length scale is usually contracted for sake of convenience in working and in order more accurately and quickly to fair the waterlines and sheer lines.

When the lines are fair the following particulars are transferred to the scrive board:—

1. Waterlines and buttocks (or vertical longitudinal sections) used in fairing.
2. Shape of every frame (port and starboard).
3. Deck lines giving heights in ship and lengths of beams.
4. Laps of plate-edges in shell plating.
5. Intersection of stringers, keelsons, bilge-keel, etc., with frames.
6. Knuckle line at stern. Height and form of bulwarks.
7. Tops of all the floor brackets.
8. Intercostals, etc.

The scrive board consists of deals, which are sometimes put together first on the mould loft by clamping them at the back in parts, and afterwards they are taken down to the vicinity of the bending slabs and furnace after the information has been transferred in the mould loft. Other times these deals are a permanant fixture near the furnaces, the lines being taken from the mould loft and scrived in on these fixed boards. The frames or angle bars, as they are ordered, should be stowed conveniently near the boards.

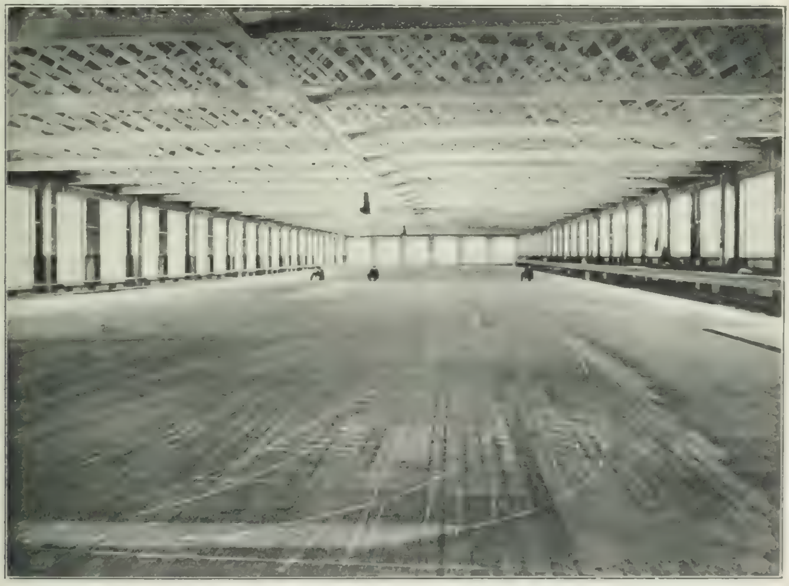


FIG. 3. INTERIOR OF MOULD LOFT, HARLAND & WOLFF, BELFAST.

Here were laid down the lines of the Oceanic and the newly launched Celtic, the largest steamers now afloat.

The first operation is usually to punch the frames. The holes are

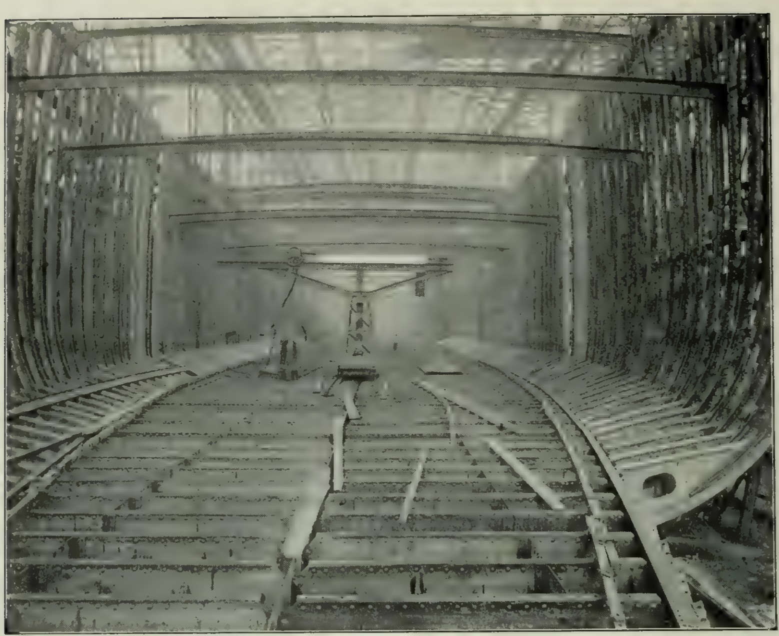


FIG. 4.—INTERIOR OF LARGE STEAMER, SHOWING FRAMING AND HYDRAULIC CRANE AND RIVETTER.

Ship-yard of C. C. Swan & Hunter.

determined by reference to the scrive boards, the information as to fixed position of laps, etc., being transferred by means of a flexible batten. After the frame is punched it is cut to its proper length and afterwards placed in the furnace. While heating, a set iron is prepared to the shape of the frame as laid down on the scrive board. As the frame is drawn out of the furnace, it is first bevelled either by the bevelling machine or by hand levers on the bending slabs, and if still hot enough, is bent and pinned to the mould of the set iron. If it is not hot enough for bending it is reheated. It is then ready to be taken to the building berth for incorporation into the framework of the vessel.

The beams form an important part of the framing. They are usually worked in a separate shed, near the scrive board. The holes are first punched, then their ends are heated in an open hearth and the knees formed. One method of forming this knee is to split the beam, open it out to the required angle, and weld a piece in the opening thus formed. The beams are then bent in a bending machine to the required round up; afterwards they are cut to the exact length and the knees cut to the required bevel. The beams are then ready to be taken to the building berth.

When the frames and beams have been adjusted to shape, they are taken to the head of the slip appropriated to the building of the ship and the necessary rivetting operations are performed on the transverse frames. Each frame, as this is completed, is transported to its position on the keel and with its beam is erected or raised up to its actual position in the ship. The longitudinal framing is placed between the frames as they go up, and the whole is kept in place by wooden ribbands which are bolted to the frames. The ribbands fair the ship to the desired form, and the longitudinal framing is then rivetted to the transverse. During this operation the transverse water-tight bulkheads are being prepared on the boards, sometimes in a shed separated from the framing shed, and they are erected as soon as possible after the framing. They also help to fair the ship. Figure 4 gives an idea of the framing of a ship.

2:—Plating. On the form shown in Figure 4 is placed the plating, which forms either the sides of the ship or the decks, the outside or shell plating being attached to the frames and the deck plating to the beams.

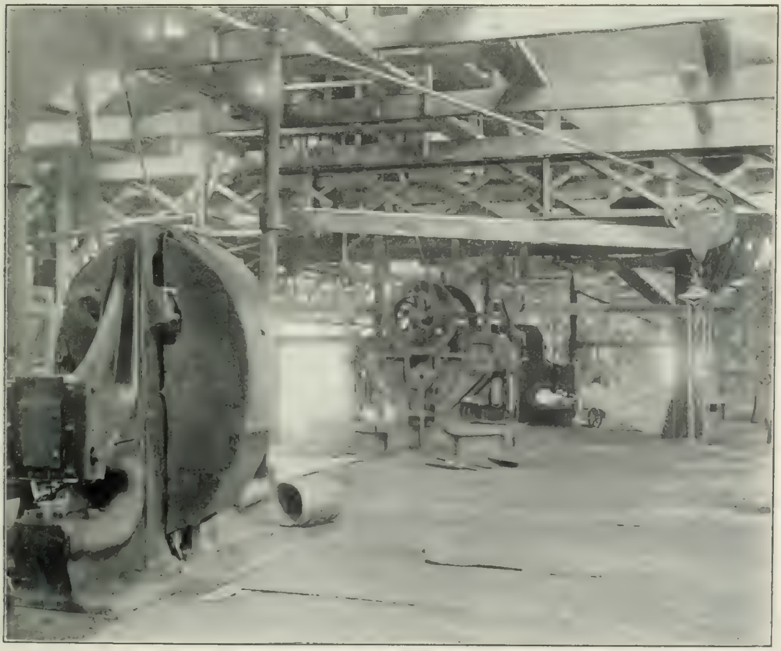


FIG. 5.—VIEW IN THE PLATING SHED.

These plates are rivetted to the frames or beams and the plating is caulked at its edges where necessary to make it water-tight. The operations of making these plates ready for rivetting are carried out in the plating shed, which is usually in one with the shed over the furnaces. Figures 5, 6, and 7 are views of machinery in the plating shed. Except in a few cases, such as plates at the counter, the plating does not require to undergo the operation of heating. The plates forming intercostals, bulkheads, brackets, etc., are worked first. For these plates moulds have been previously prepared at the mould loft, or their shape is taken from the scrive board. Shell or deck plates generally are not begun until the framing is well advanced and faired, though a few may be used for the process of fairing. A template for each plate is made on the framing to the exact size of the plate, and all the holes already in the framing are marked on it. This information is then transferred to the plate. The holes marked through from the template are first punched, then the plate is sheared, generally at the same machine as the punching, to near its exact size. Afterwards the holes are countersunk, the edges and butts planed, and the plate passed through either the bending or the straightening rolls. The last operation is to joggle the edges and ends if the system of joggling is employed.

The full details of the methods of obtaining the necessary information for the preparation of any given element of construction are

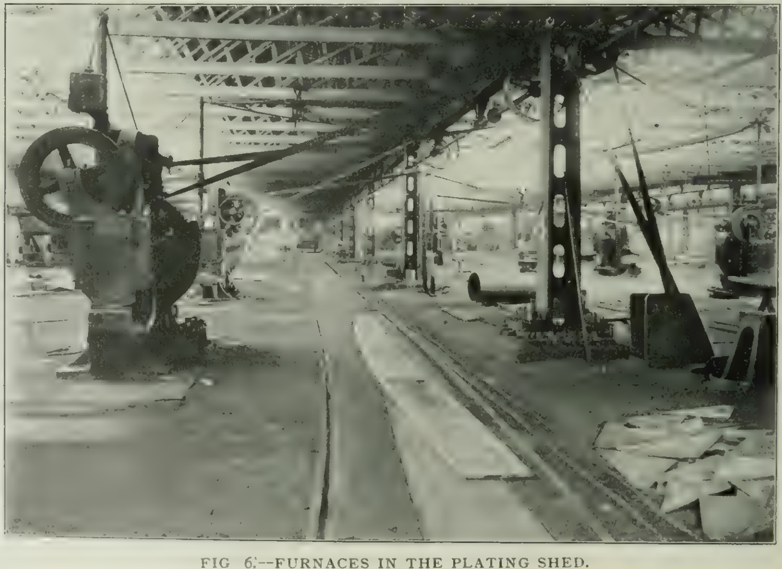


FIG 6.--FURNACES IN THE PLATING SHED.

Denny & Bros., Dumbarton.

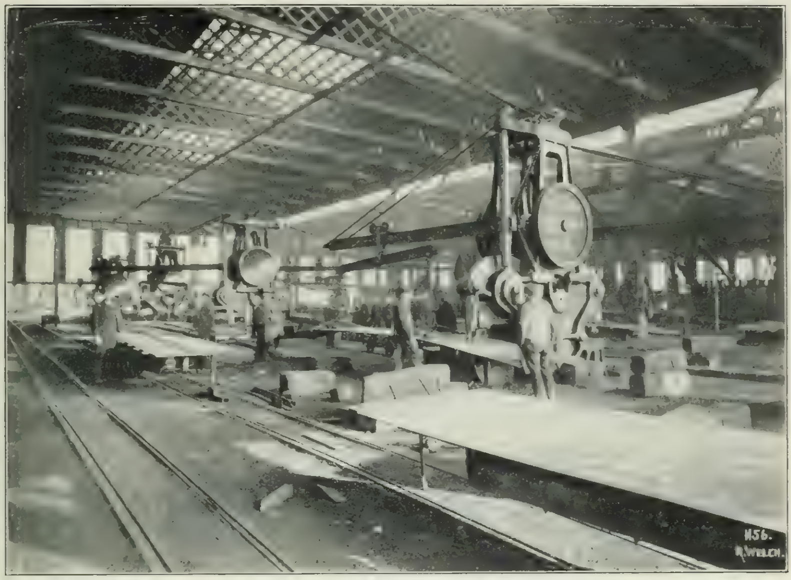


FIG. 7—PLATERS' SHED, HARLAND & WOLFF, BELFAST.
A plate being punched.

scarcely within the scope of this article, but in connection with this branch of the subject it may be noticed that a considerable amount of time and expense may often be saved by making as many parts as possible exactly similar. Carefully prepared templates of any special part can easily be made in the earlier stages of construction, which will allow these parts to be proceeded with concurrently with some of the earlier operations, instead of, as has often been the case, waiting until the construction had advanced to a later stage and then making a template from the vessel herself. The former system—of making as many parts as possible to one template, and using templates obtained from the mould loft for various elements—has reached a high pitch in the ship-building yards on the Great Lakes in America. In many cases the whole of the shell plating, deck plating, transverse frames, the chocks, keelsons, and inner-bottom framing which constitue the longitudinal framing for nearly three-fourths of the vessel's length, are prepared from a few templates, so that the process of building becomes one of bolting the various parts together. And if the work has been carefully performed no anxiety need be felt as to any parts not fitting properly.

What may be called the essential machines for the iron and steel work connected with a ship consist of those for punching, shearing, planing, and countersinking operations. The first two of these, whether for use upon plates or angles, are almost always combined in one machine. The are driven either independently or by belts and shafting driven by an engine at a central station. Into the merits or otherwise of each system it is unnecessary to enquire here, as the circumstances in every case require special consideration, but where a number of these machines are grouped in one shed they may be driven by the latter means with advantage. The scope of a punching machine, as measured by the distance between the centre of the punch

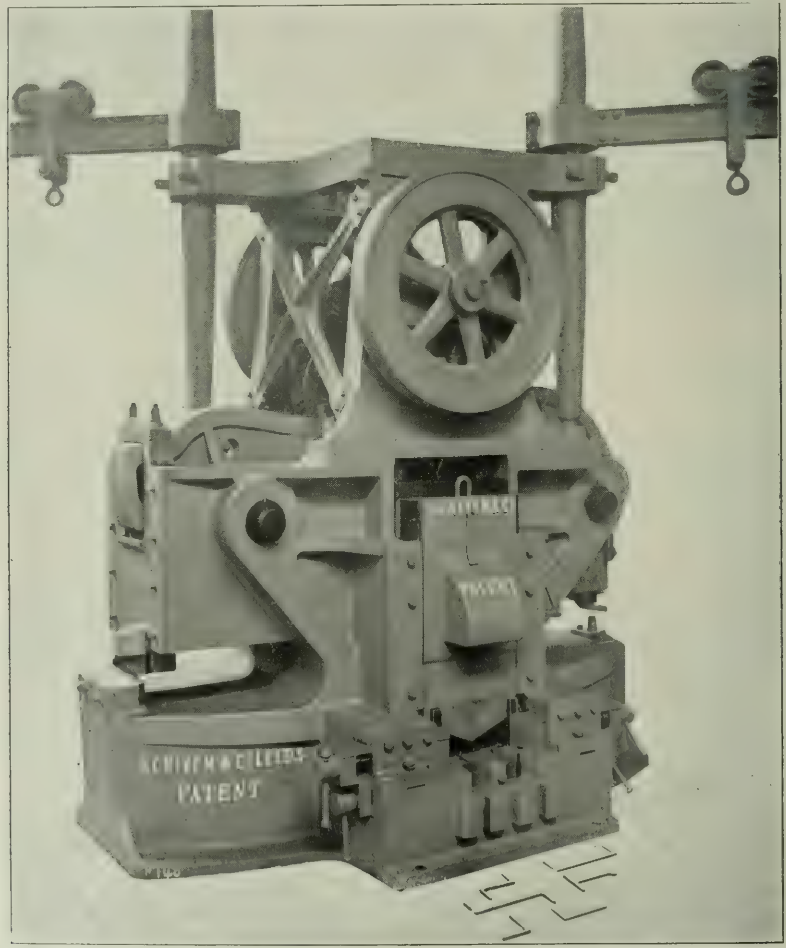


FIG 8—PUNCHING, SHEARING, AND ANGLE-CUTTING MACHINE.
Punches [illegible]-inch holes through 1½-inch steel plates 36 inches from the edge, and shears 1½-inch steel plates 33 inches from the edge; has patent cutting arrangement for channels, tees, and angle bars.

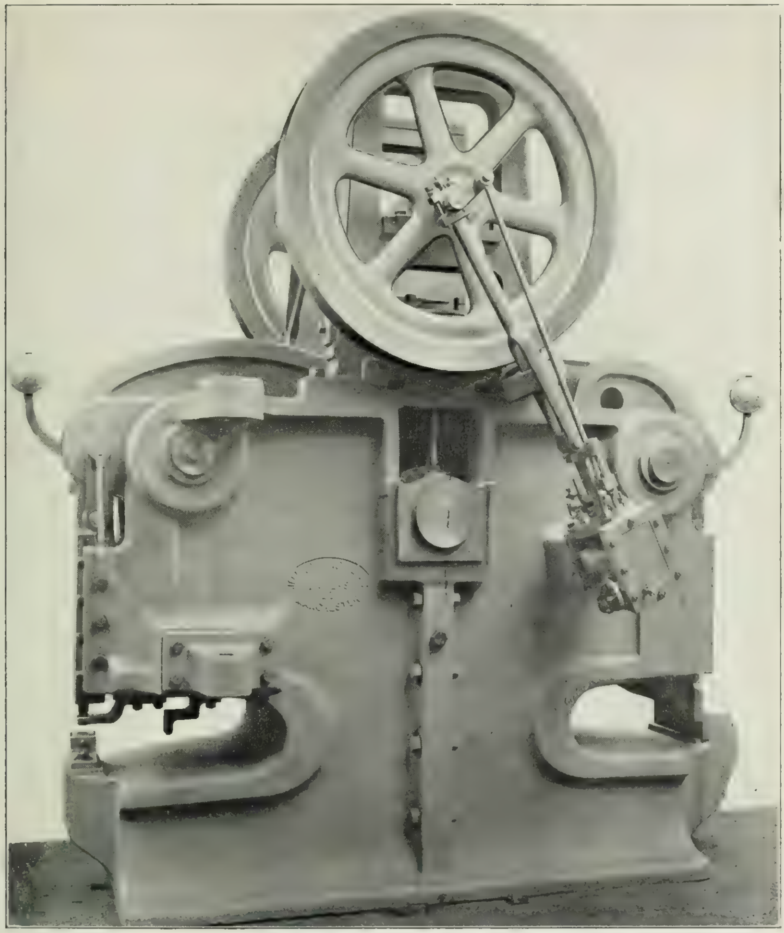


FIG. 9.—PUNCHING AND SHEARING MACHINE.

John Hetherington & Sons, Manchester.

and the back of the gap of the machine, has an important bearing on the cost of certain parts of a ship's structure, such as deck-plating, shell plating, etc. The width of plate that can be punched is limited to about twice the width of the gap, so that the number of strakes of plating is practically fixed by this factor, and in some cases the adoption of a wide-gap machine may lead to the reduction in the number of strakes in the shell and decks and to the consequent saving in rows of rivets, as each strake of plating saved involves the saving of the rivets in one edge of a plate.

The Punching Machine:—See Figures 8 to 17. The essential parts of this machine consist of a punch and a die or hole, directly in line with each other, at the end of a wide gap. The punch is set in a strong slide which receives its motion from a lever worked by a cam. The motion is governed by a heavy fly-wheel on the driving shaft. A lever is fitted for disengaging the punch slide so as to bring it under the control of the workman, who guides the plate and only allows the machine to pierce when the part to be pierced is directly in line with the punch. A plate when being punched is held horizontally in the gap (Figure 7). The plate is supported by hooked chains from a

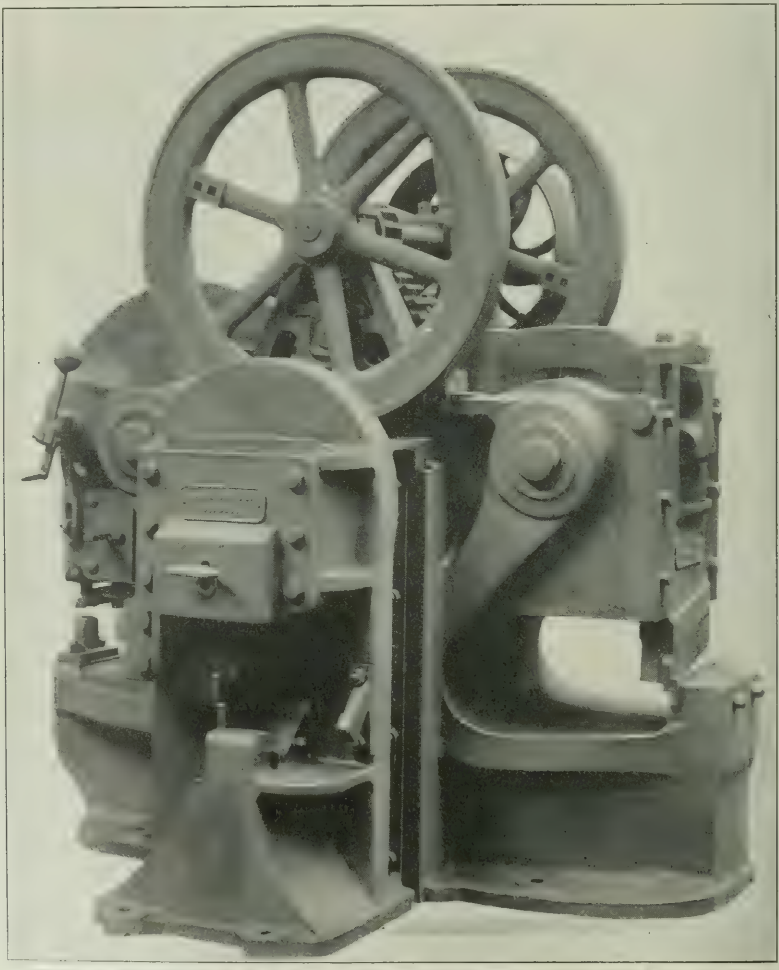


FIG. 11.—CAM LEVER PUNCHING AND SHEARING MACHINE FOR THE HEAVIEST CLASS OF SHIP-BUILDING WORK.
Loudon Bros., Glasgow.

runner moving along the horizontal jib of a crane attached to the machine, and free to turn horizontally. This crane is provided on all machines for punching and shearing plates. A large plate, however, requires three or more workmen to guide it, one workman having control of the punching slide. Between each two strokes of the punch the plate is shifted. A point to notice here is that the cam which drives the punch slide is of the quick-return type, thus giving the advantage of having a longer time for changing the position of the plate from the moment the punch is clear of the plate until it again touches the plate.

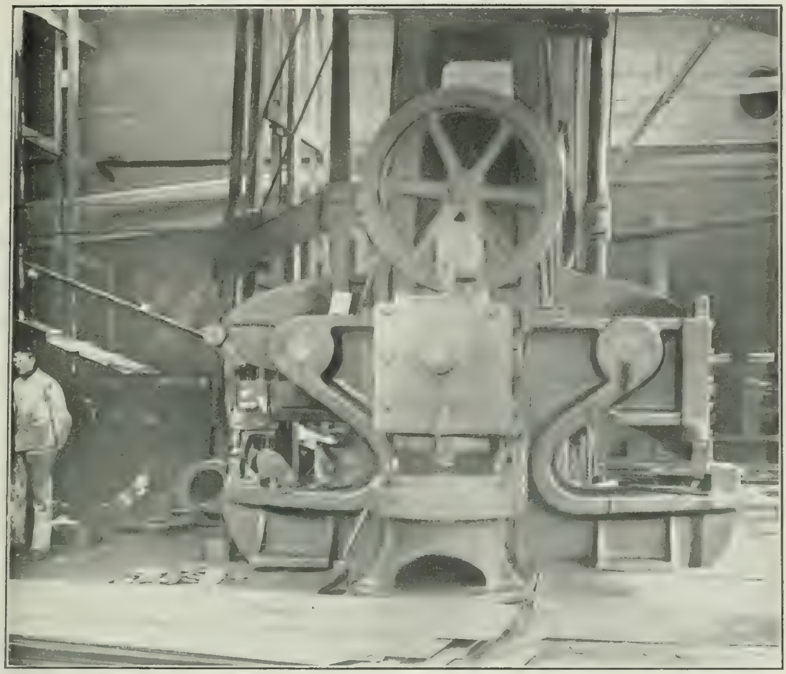


FIG. 10—COMBINATION PUNCH, SHEAR, AND MANHOLE PUNCH IN THE UNION IRON WORKS, SAN FRANCISCO.
Bement, Miles & Co., Phila

Figure 15 is an example of the type of punching machines used for angle bars, etc. The chief features here are that the punch slide works horizontally and that no wide gap is required. The number of strokes per minute is regulated in nearly all cases from practical considerations—*i. e.*, the time taken after one hole has been punched to move the plate into position for the next. If all the holes are centre-punched in the first place and a tip punch used, the number of strokes per minute may be increased.

The Shearing Machine:—See Figures 8 to 14. The material is sheared between two steel blades set at an angle. The moving blade is set in a slide which receives its motion from a lever worked by an eccentric. This shear slide, like the punch slide, is provided with disengaging motion. When shearing a plate the plate is supported and worked in the same manner as when being punched. These machines have gaps of dimensions similar to those of the punching machines.

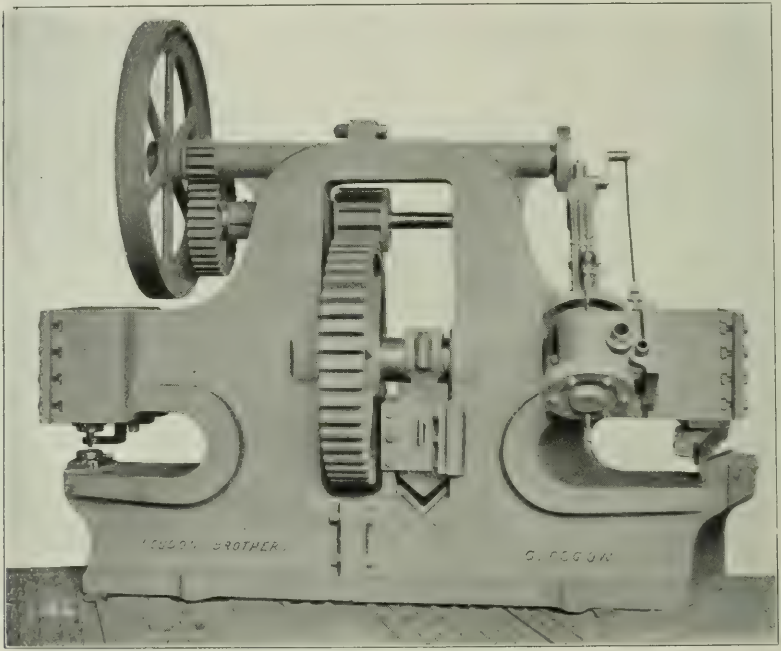


FIG. 12.—PUNCHING, SHEARING, AND ANGLE-BAR-CUTTING MACHINE.
Loudon Bros., Glasgow.

For cutting angle-bars, channel-bars, etc., the blades are designed so as to shear all the flanges at the same time. Examples are seen in the Figures 8 and 12.

Figure 8 shows a machine capable of punching 1½-inch holes in 1½-inch steel plates at one end, and shearing 1½-inch steel plates at the other end, 36 inches and 33 inches from the edge; it is fitted with disengaging motion to both punching and shearing rams. Provision is made, as in most punching and shearing machines, for two jib cranes, one on each side of the machine. Figure 9 is a machine of similar size but another type, being without the angle-bar cutting attachment.

Figure 14 is a punching, shearing- and angle-cutting machine, the angle-iron shear receiving its motion from an eccentric on the end of the main driving shaft. Figure 11 is another example of a punching, shearing and man-hole punching machine. In this illustration the jib cranes are shown in position. Figure 12 is a heavy machine with angle-iron cutter. Figure 13 is a similar machine, capable of punching 1¼-inch holes through 1¼-inch plate, of shearing 1¼-inch plates, and of cutting 6-inch by 6-inch by ¾-inch angle bars. The angle-cutter is specially arranged to allow for the angle bars passing through the body of the machine.

The addition of an angle-bar cutter to the punching and shearing machines may prove useful in special cases, and for small establishments, but where the plate and angles are worked in separate parts of the shed this fitting is superfluous.

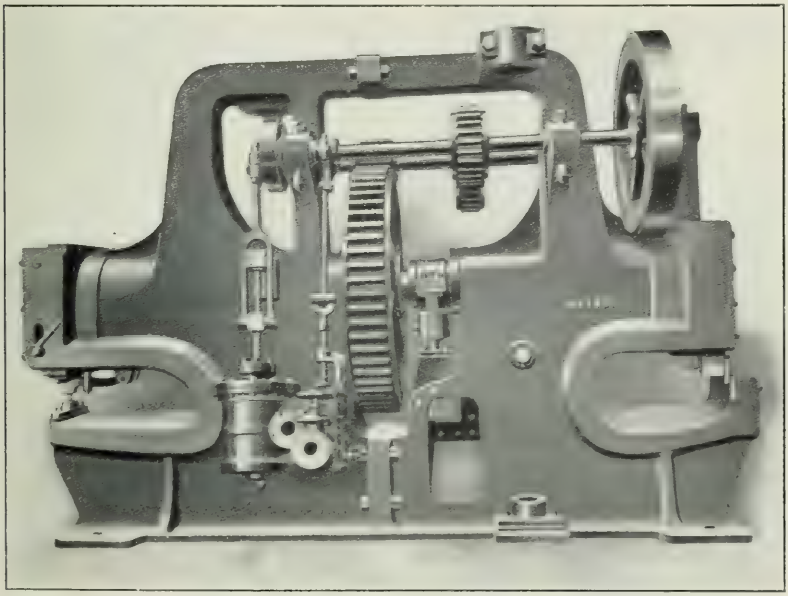


FIG. 13.—PUNCHING, SHEARING, AND ANGLE-CUTTING MACHINE

Punches 1¼-inch holes in 1¼-inch plate, 30 inches from edge; shears 1¼-inch plate 24 inches from edge; cuts 6 inch by 6 inch angles; driven by 10-inch cylinder engine. Craig & Donald, Johnstone.

Figure 15 is a combined beam or angle bar bending and horizontal punching machine capable of bending or straightening up to 12-inch butterfly or 14-inch ordinary beams, of punching 1¼-inch hole through 1¼-inch plate; in other forms of this machine there are also, for cutting angle bars, two sets of shears at the centre (right and left) capable of cutting to 10-inch by ¾-inch angle bar. It will be noted in these machines that there is no width of gap and that the motion of the punch is horizontal. This type is specially designed for angle bars. In other forms, it is made heavy enough to cut 12-inch by 6-inch by ¾-inch angles. The advantage of the bending or straightening attachment in Figure 15 effects a certain economy, as it saves moving the piece from one machine to another.

Figure 16 is a double-ended machine with twin punches. It is capable of punching, at each end, two holes 1-inch diameter through 1-inch thickness of steel plate, at each fall of the slide. The depth of the gap is 42 inches.

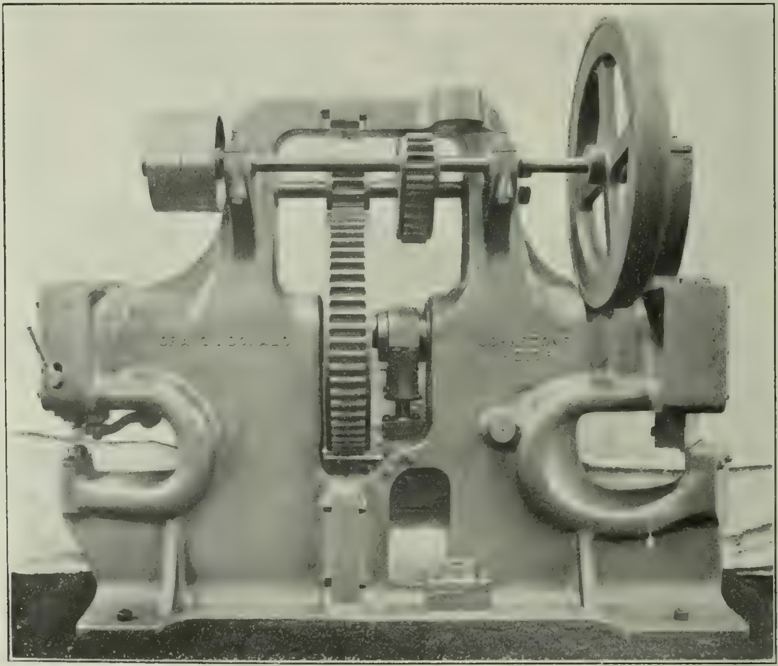


FIG. 15. ANOTHER VIEW OF THE PUNCHING, SHEARING, AND ANGLE CUTTING MACHINE.

Figure 17 is a double-ended punching machine, having at the centre a side cutting or notching machine. The addition of this attachment is an advantage. The notching of the stringer plates in the way of frames involves a considerable amount of time if this is done by means of close punching, and as this machine is capable of notching any size up to 10 inches by 8 inches at one stroke, the saving of time by this means is evident. The figure also shows an arrangement

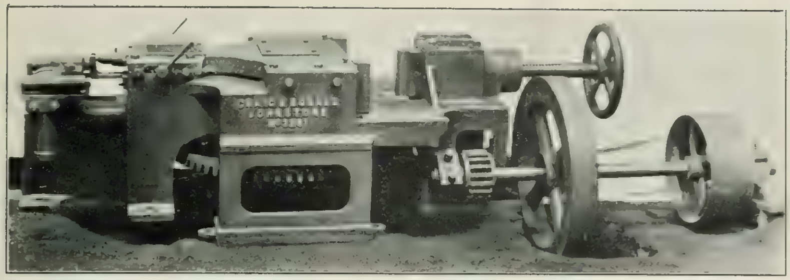


FIG. 15.—COMBINED BEAM-BENDING AND HORIZONTAL PUNCHING MACHINE.

Capable of bending or straightening 14-inch beams and of punching 1¼-inch holes through 1¼-inch plate.

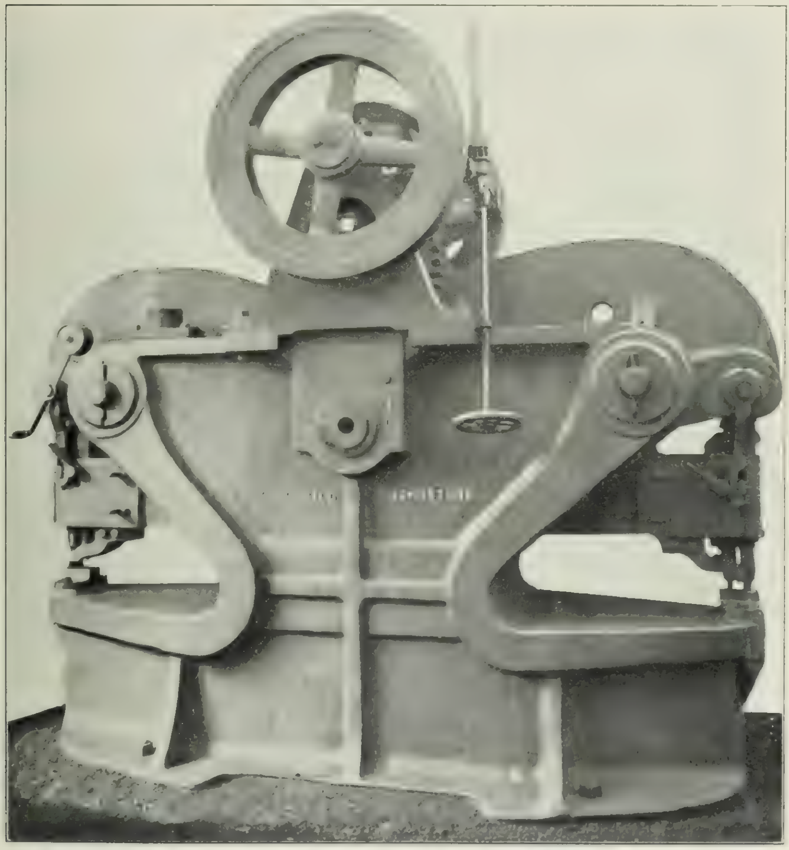


FIG. 16.—DOUBLE-ENDED TWIN PUNCHING MACHINE.

Punches two 1-inch holes at each end through 1 inch plate, or one 1½-inch hole at each end through 1½ inch plate. Supplied to Clydebank and Denny & Bros.

for punching two holes at one time, but as there is an independent stop motion to each punch this machine may be used for single punching. The gaps at each end are 48 inches deep.

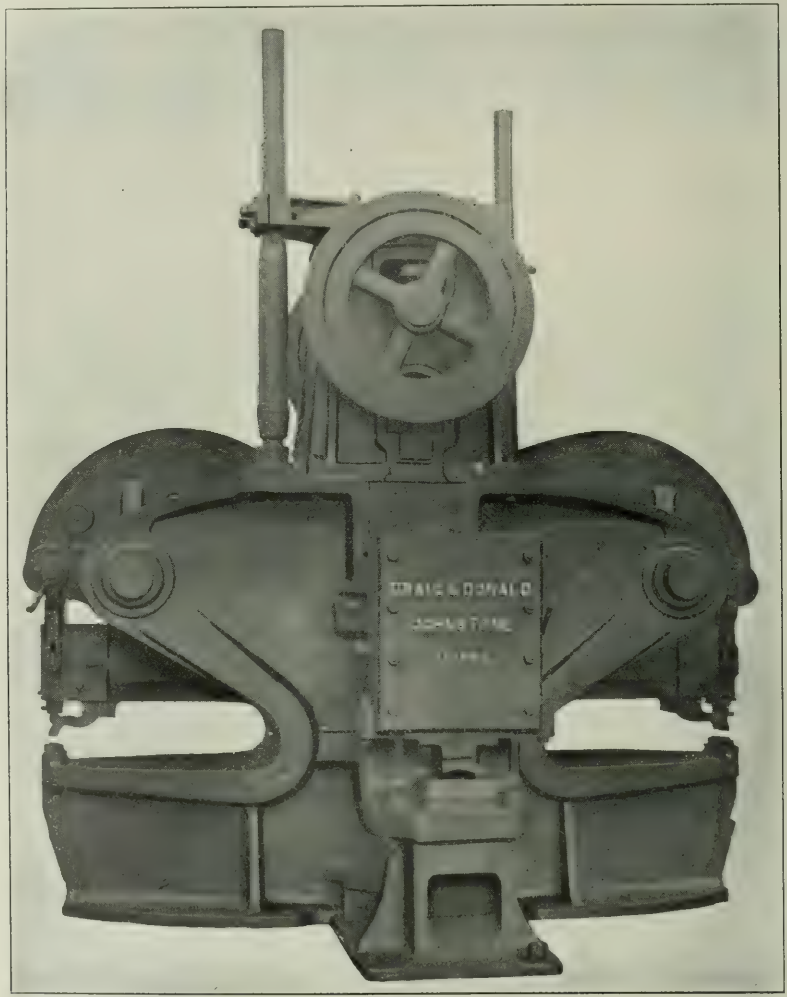


FIG. 17.—DOUBLE-ENDED TWIN PUNCHING MACHINE OF CAM AND LEVER TYPE, WITH SIDE-NOTCHING ARRANGEMENT.

Capable of punching constantly 1½-inch holes in 1½-inch plates, with both gaps 48 inches deep, and of cutting notches in stringer plates up to 10 by 8 by ⅞ inches. Crane posts are shown, ready for attaching suitable cranes.

Figure 18, on page 206, is an example of a small channel-cutting machine capable of cutting up to 8-inch by 4-inch channel bar. It can be arranged to cut an equivalent section of angle iron. The hand wheel

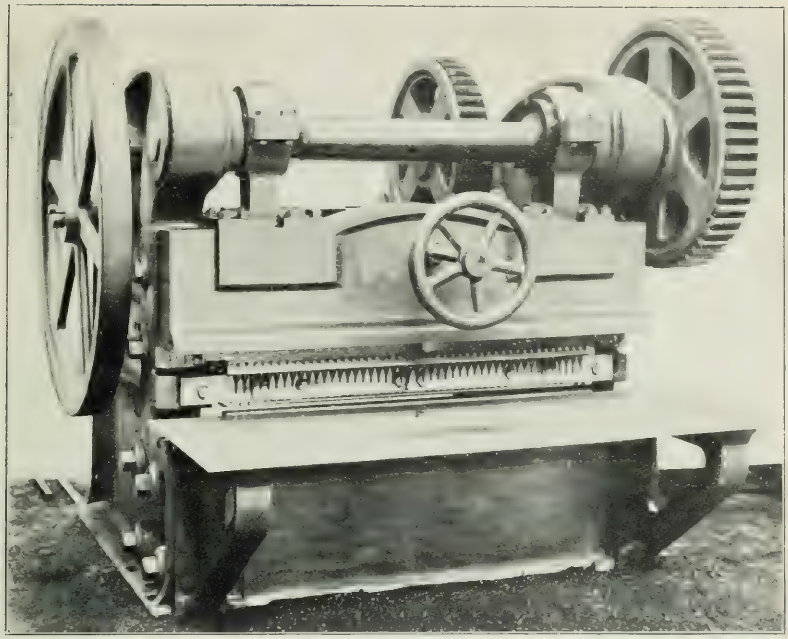


FIG. 19.—MULTIPLE PUNCHING MACHINE.

Punches 47 holes 7-16-inch diameter through 7-16-inch plate at one fall of slide. Will pass a 4-foot plate through. Specially adapted to ship-tank work. Craig & Donald.

FIG. 20.—MULTIPLE PUNCHING MACHINE IN THE PONTOON YARD, C. S. SWAN & HUNTER, NEWCASTLE-ON-TYNE

De Bergue & Co., Manchester.

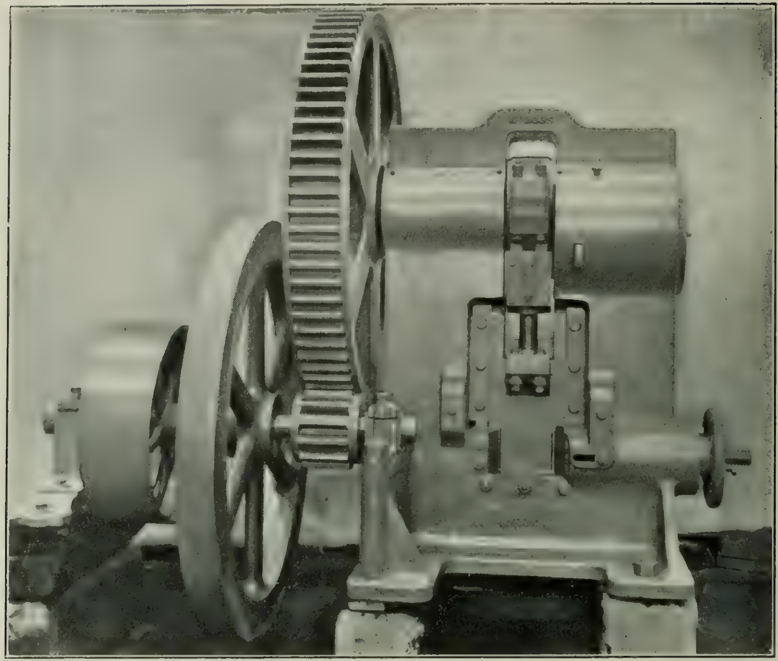


FIG. 18—CHANNEL CUTTING MACHINE

Cuts up to 8-inch by 4-inch channel iron, and can also be arranged to cut an equal section of angle iron.

actuates the side blades so as to vary the sizes of the cut for different sizes of channels that are used.

The multiple-punching machine (examples of which are shown in Figures 19 and 20) is not much used for ordinary ship work, although in long full vessels such a machine might prove a saving of time. It is used principally for tank work and for structures such as floating docks, where the spacing of the rivets does not change, as there is no change of form. If the construction of a ship be so arranged that most of the work can be done by templates, such machines will come to be of the first importance.

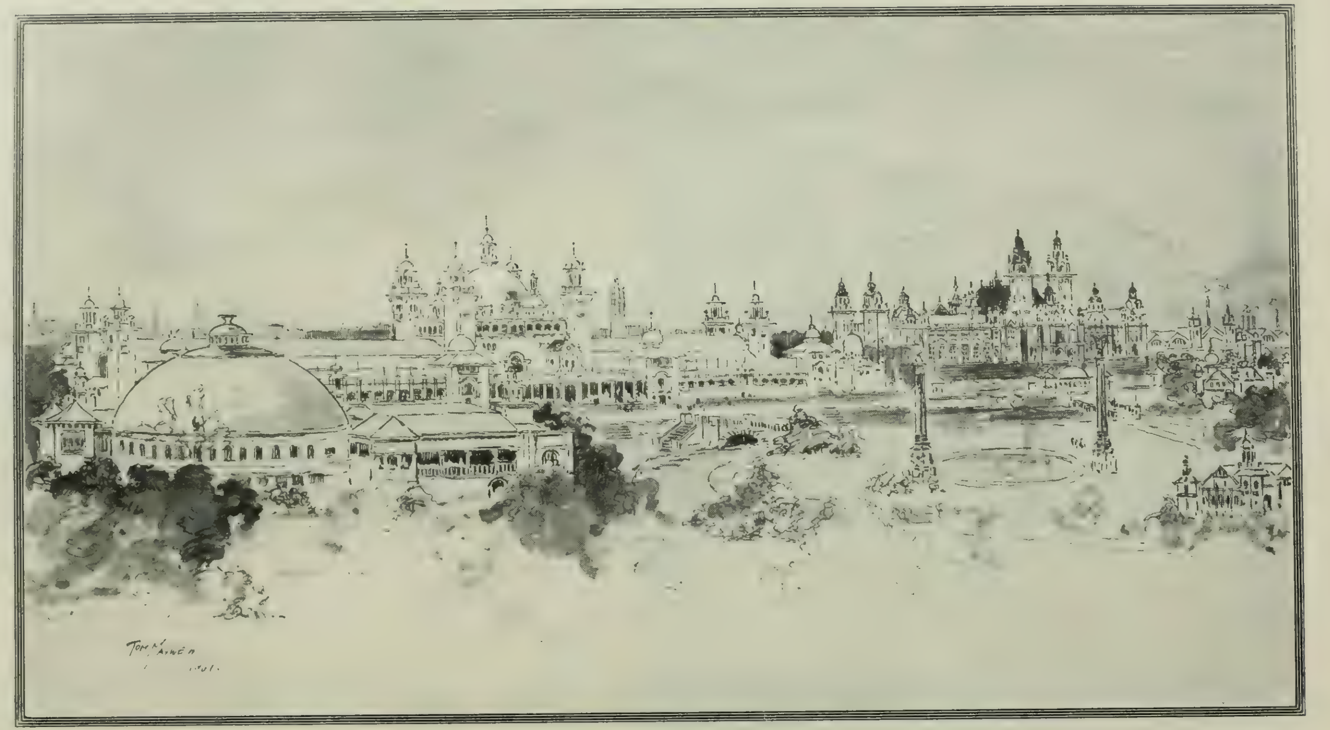
In the succeeding article I shall take up the larger tools employed more particularly in working the plating of a ship.

SCOPE AND SIGNIFICANCE OF THE GLASGOW INTERNATIONAL EXHIBITION.

By Benjamin Taylor.

The international exposition has always been an active influence in modifying and improving manufacturing methods. It takes on yet greater importance with the rapidly growing activity in engineering throughout the world, and with the concentration of interest on the mechanical processes and products which form so large a feature of the modern exposition. The coming summer will witness two great enterprises of this kind—one at Glasgow, near the heart of Britain's greatest steel-making and ship-building district, the other at Buffalo, in close touch with the same industries in the United States. The salient features of both will be reviewed in these pages later in the summer. Mr. Taylor gives below a summary of the most important portions of the Glasgow Exhibition.—THE EDITORS.

EARLY in May the International Exhibition at Glasgow will be opened, remaining open until November. It is mainly and essentially, though not exclusively, an Exposition of the mechanical and industrial development of the age, and is held in the second city in the British Empire, in the first year of the twentieth century. It is promoted, organised and administered in one of the busiest and most progressive industrial centres of Europe, by some of the most experienced and progressive mechanicians and industrial producers in the world. And in association with the Exhibition during the summer and autumn will be held at Glasgow the annual conferences of the British Association, the Institute of Mechanical Engineers, the Society of Engineers and Ship builders, the International Engineering Congress, the Institute of Naval Architects, and other technical and scientific bodies. Its avowed object is the display of the manufactures, natural products, industries, and material resources of all nations; of the machinery, plant, and appliances relating thereto; and of articles illustrative of science and art. But in especial it is intended to present a full illustration of the resources of the dependencies, dominions, and colonies of the British Empire, and the progress in industry, science, and art of *all* nationalities, during the nineteenth century. A broad indication of the scope of the Exposition is furnished by its scheme of division into the following chief classes: (1) Raw material, both agricultural and mineral;



Grand Hall. Dome and Grand Entrance. Fine Arts Building.

FRONT VIEW OF THE MAIN BUILDINGS, GLASGOW INTERNATIONAL EXHIBITION.

Specially drawn for The Engineering Magazine.

(2) Industrial design and manufacture; (3) Machinery of all sorts in motion, electricity, and labour-saving devices; (4) Locomotion and transport; (5) Marine engineering and ship-building; (6) Lighting and heating; (7) Science and scientific instruments, education, and music; (8) Sports and sporting appliances; (9) Women's industries; (10) Fine arts, Scottish history, and archaeology. Some only of these sections come within the scope of this journal, and may call for detailed notice hereafter. The purpose of the present article is to give a general idea of the character of the undertaking, and some information about the structural and engineering aspect of the equipment.

The Exhibition starts with a guarantee fund of half a million sterling, raised by citizens of Glasgow. The Corporation of Glasgow provides the site—a fine one in Kelvingrove Park at the west end of the city, and just under the shade of the classic University, whose four hundred and fiftieth anniversary will be celebrated while the show is in progress. The site is practically identical with that of the Exhibition of 1888, and the two undertakings are associated by the fact that a surplus of £54,000 left by the 1888 enterprise was supplemented by the subscriptions of private citizens to the amount of £74,346, augmented to £250,000 out of municipal funds, and applied to the erection of permanent fine art galleries, which form part of the present Exhibition buildings. The area of the Exhibition buildings and grounds is seventy-three acres, and the grounds are intersected by the River Kelvin. The University buildings bound the area on the north, and the ornamental flower-plots, ponds, and fountains of the Kelvingrove Park are included in the grounds. The River Kelvin will be utilised for the exhibition of ship-building and life-saving apparatus, either in motion or stationary, although the reach which can be utilised for this purpose is comparatively short.

The buildings alone, which are from the design of Mr. James Miller, I.A., Glasgow, cover an area (inclusive of the permanent fine art galleries) of about twenty acres. Excluding these permanent galleries, which do not call for attention here, there are three main groups of temporary buildings, comprising the general industrial section, the machinery hall, and the grand hall for entertainments. The main or industrial section, with the grand dome in the centre, is 700 feet long and 330 feet wide, and covers nearly six acres. Through the centre runs the main avenue, 60 feet in width and about 70 feet high, having a circular-arched steel roof. This main avenue is not in any way divided by courts, and the whole space is an unbroken area. Steel was originally selected to be the structural material throughout, but when the price advanced so greatly above what was contemplated when the plans were drawn, the building committee arranged for timber construction for large portions of the side and wing erections.

The general appearance of the buildings externally is Eastern. The architectural style is Spanish Renaissance, but with distinctly Oriental features lending to brightness and gaiety of colour. The leading architectural feature of the structure is the great dome, 200 feet in height, 80 feet in diameter, with four white towers each rising to a height of about 160 feet above the level of the grounds. Surrounding this dome, at a height of about 100 feet from the ground, is a balcony 400 feet in circumference and averaging 25 feet wide, forming a grand promenade, from which an extensive view of the grounds and of the city and surrounding country is obtained. This balcony is reached by spacious staircases and by powerful lifts in the towers. The grand entrance is situated under the great dome, and is led up to by an extensive peristyle, or colonnade, 200 feet long by about 80 feet wide, the floor of which is laid with white marble with an ornamental design in black. In front of the peristyle is a fine flight of steps extending the entire length of the colonnade. At each corner of the building, and on the north and south fronts towards the centre, are pavilions about 35 feet square, each having four lofty minarets at the angles, terminating with domical roofs.

In the industrial hall are the industrial and applied-art exhibits. In the machinery hall, attached to it by a wide curved and covered avenue, is all the machinery in motion and stationary. And in various parts of the grounds are special buildings devoted to the displays of France, Russia, Japan, Canada, Persia, Morocco, and other countries, and many others devoted to purposes of refreshment and entertainment.

America has not a separate section, but American exhibits occupy a large space in the machinery hall. Next to Great Britain, Russia is the largest exhibitor. M. Witte, Minister of Finance, announced to the Lord Provost of Glasgow the Czar's desire that Russia should be largely represented, so that "The participation of Russia in the Glasgow Exhibition will be a new step towards the establishment and consolidation of the amicable relations which are so important for both countries." So large were the demands of Russia for space that a section of the ground had to be set apart entirely for her requirements. The Government of the Czar made a grant of £30,000 for the erection of suitable buildings, and Imperial commissioners were appointed to prepare and supervise the Russian section—the first which Russia has ever had at an International Exhibition within the United Kingdom. Over two acres are required to accommodate the buildings sanctioned by the Imperial Government. The four principal pavilions are devoted to agriculture, minerals, forestry, and the products of the Imperial estates. All are designed in old Russian style, and the ornamentation and other features are exactly as they appear to-day in the northern parts of the Empire. They were put up by Russian workmen sent specially from St. Petersburg, who worked for ten hours daily in spite of short winter days and bad weather, and with a short-handled axe as almost sole instrument. It serves for all kinds of jobs. After the original plans were passed it was decided to erect two smaller pavilions—one for a collection of grain from all the producing districts, the other for the use of the Millers' Association of Russia, also a grand reception hall for the use of distinguished visitors from Russia. In the industrial hall Russia has, besides, over 11,000 square feet of space, for a varied display of the country's manufactures and products. Russian industries will be shown in operation, and there are a Russian restaurant, band, choirs, and other national features.

So much by way of general view, and now let us look more particularly at the structure of the Exhibition buildings. These present many interesting features. In the case of the industrial hall, difficulty was at the outset encountered in obtaining a suitable foundation, owing to the treacherous nature of the ground covered by a building which will be so heavily loaded. The ground is mostly silt and mud, but at one place near the dome, rock rises nearly perpendicularly to the surface. A portion of the main towers and dome was founded on this rock, while the remaining portions are dependent upon the soft silt for their support. Thus special foundations had to be designed to prevent uneven settlement, and the remainder of the foundations were floated or spread over a sufficient area to secure this. On entering the interior one is struck with the light and lofty appearance, due to the judicious use of iron-work, which has been so designed as to give large uninterrupted floor space. The main avenue of the industrial hall has a roof span of 103 feet, which is contracted to 50 feet at the centre by the dome supports and adjoining four main towers. This roof is designed on the "three-hinged arch" principle, to counterbalance the expansion and contraction resulting from changes of temperature. The legs of the main trusses are hinged or supported on steel pins attached to steel bed-plates, which rest upon and are secured by means of bolts to the concrete foundations, the third hinge being placed at the apex of the roof, which is about 60 feet above the floor level. The main trusses or principals are spaced about 40 feet apart, and, in addition to carrying the roof over the avenue, are saddled with the ends of the supporting girders of the side roofs, and resist the wind pressure against the face walls, which is taken up and conveyed through the girders to the trusses. Thus the stability of the immense structure is almost entirely dependent upon the strength of the central span, to which all stresses are conveyed. The principals are elliptically shaped on the underside, and formed of latticed steel work. A series of elliptically shaped open steel-work arches connect the principals along either side of the avenue, and give entrance to the side avenue. The roof is covered with glass and corrugated iron, supported by intermediate steel rafters and purlins, ventilation being provided on either side at the ridge for the whole length of the building. The side avenues are covered with roofs of timber of a novel design, and are remarkable for lightness. They are carried by timber girders extending from, and in line with, the principals of the main avenue to the face-walls. These roofs are also covered with corrugated-steel sheeting and glass.

The dome is covered on the outside with timber and sheet-iron, and internally with fibrous plaster. The whole framework of the Exhibition buildings is covered with fibrous plaster boards, faced with pure white stucco, and forming practically one piece. The corrugated-iron roof is painted to resemble red tiling. Green is also largely used for decorative effect, and the domes and minarets are gilded.

The industrial hall is connected with the machinery hall by the grand avenue, which by means of a roofed cantilever bridge crosses over the Dumbarton Road. This avenue has a length of 1,000 feet and a width of 75 feet. Its roof is formed of laminated timber ribs, semicircular in form, spaced 15 feet apart, with a height of 40 feet above the floor at the ridge. It is covered with glass and corrugated-steel sheeting, the sides being enclosed with fibrous plaster secured to timber framing. The covered bridge over the public road is constructed of timber, and has a clear span of 65 feet across the road with a smaller span on either side. The bridge is supported by three main girders constructed on the cantilever principle. The cantilevers rest upon cast-iron columns, and the anchor arms are securely anchored and weighted with concrete blocks. The floor decking is supported by cross girders, and the whole is covered with a light timber roof.

By means of this spacious avenue we reach the machinery hall, in which most of the readers of this Magazine will find the greatest concentration of interest. A word, therefore, is due to its structure. It is erected outside the park and on what is known as the Bunhouse Grounds. To adapt these grounds for that purpose, and to give a level floor space, a large amount of excavation had to be done, and it was also necessary to construct a retaining wall to uphold the Dumbarton Road and a street. The machinery hall is 500 feet long and 320 feet wide. It is divided into a central and four side avenues. The central avenue has a span of 108 feet 6 inches, is covered by an arched steel roof of open girder work, supported by double columns placed eight feet apart and braced together by arched lattice girders. The columns, which are of steel, in addition to supporting the main roof and the adjoining side spans also carry a gallery with lines of shafting underneath, for conveying power to work the machinery exhibited. The columns, with the intermediate bracing, also resist the wind pressure from the side walls, which is conveyed to them through the roof members of the side spans. They are connected longitudinally by a double row of arched open girders of steel, which extend along either side of the central avenue from end to end of the building, and under these the gallery is carried by light lattice girders supported by cantilevers attached to the columns. The roof covering is similar to that of the other buildings. The gallery, which has a width of 16 feet, is carried right around the main avenue, and connects directly with, and is on the same level as, the floor of the bridge over the Dumbarton Road. Access to the floor of the machinery hall, which is 12 feet lower, is obtained by broad flights of stairs at either end of the hall. The side roofs of the hall, which have a uniform span of 53 feet, are supported by a series of steel latticed and tapered columns, connected by latticed box girders of steel. These columns and girders also carry lines of shafting for conveying power for working exhibits. The roofs of the side spans are of timber and steel. (For the technical details of this interesting structure I am indebted to the engineer.)

The dynamo house extends beyond the main building of the machinery hall at its southwest corner, and is formed by a continuation of the side spans of the main building. It is 100 feet square. The boiler house extends along the west side, is 204 feet long and 70 feet wide, and covers an area of 1,600 square yards. It is covered by a roof of one span of open timber work, and surrounded by a gallery from which the various boilers, economisers, etc., in use can be conveniently viewed. Sidings, with loading banks and electric and other cranes, are provided alongside the boiler-house and machinery hall, in direct communication with the Caledonian Railway system, for the delivery of exhibits, coal, etc., and a spacious covered way is extended from the south end of the machinery hall to the platform of Partick Central Station for the convenience of railway passengers. Space is given by preference to those exhibits which will make the most interesting display and at the same time be of a representative character. The machinery will, as far as possible, be shown in motion, and, where practicable, actual manufacturing will be carried on. The machinery hall covers an area of five acres. The generating station is at the southwest end.

The motive power for the machinery on exhibit is supplied by four Lancashire boilers, 30 feet by 8 feet, working at a pressure of 120 pounds per square inch, made by Penman & Co., Glasgow; and installations of water-tube boilers supplied by Davey, Paxman & Co., the Stirling Boiler Company, and Babcock & Wilcox. The water-tube boilers are used to generate steam for the electric engines at 160 pounds pressure per square inch. Almost four-fifths of the power generated in the boiler house will be transformed into electricity by means of the following, and other, working exhibits: The Edison-Swan Co., Ltd., Glasgow; a 500-brake-horse-power Browett-Lindley engine and dynamo. Mavor & Coulston, Ltd., Glasgow; a 500-brake-horse-power dynamo with a Robey compound engine. Alley & Maclellan, Glasgow; a 300-horse-power compound engine, with a Mavor & Coulson dynamo. Hick, Hargreaves & Co., Bolton; a 300-brake-horse-power compound engine, and an alternator by the Lancashire Dynamo and Motor Co., Ltd., Manchester. D. Bruce Peebles & Co., Edinburgh; a 250-kilowatt dynamo, with a Belliss engine. Robey & Co., Ltd., Lincoln; a 150-brake-horse-power engine and dynamo, and a 70-brake-horse-power engine and dynamo. Wm. Sissons & Co., Gloucester; a 125-brake-horse-power engine and Clark, Chapman & Co. dynamo. There are also on show and at work two triple-expansion engines of 1,200 horse-power each built by Willans & Robinson, Ld., Rugby, for the electric-light station of the Corporation of Glasgow, each driving a dynamo.

Altogether, in the generating station there are twelve sets of combined steam engines and dynamos, giving a total of 4,176 electrical horse power at the terminals. Mr. Thomas Young, the courteous engineer of the Exhibition, to whom I am indebted for much of the detail in this article, informs me that it is intended that five of these dynamos shall work at a pressure of 500 to 530 volts at the terminals, and seven at a pressure of 250 to 265 volts. This range in the voltage is to provide for loss in transmission to the various stations or points of distribution through the various sections of the Exhibition. Three of the dynamos are compound-wound, but all are used as shunt-wound machines, and coupled up to the bus bars of the main switchboard on the parallel system. Each dynamo is connected to the bus bars of the main switchboard through an automatic magnetic circuit-breaking switch, ampere meter, shunt regulator, and double pole. The main switchboard is also fitted with the necessary feeder logs, earth recorders, direct-reading and recording volt and ampere meters, electricity meters, circular-dial time piece, etc., and the sub- or switch distribution stations are seven in number, arranged two in the machinery hall at the northwest and southwest ends, one in the grand avenue, and three in the industrial hall. From these stations all arc and incandescent lighting is controlled. The incandescent switch and fuse boards are separate from the arc switch and fuse boards, both in the manner of erection and supply.

The exhibition will be lighted by means of Brockie-Pell 10-ampere arc lamps of various types, and incandescent lamps of various powers. In the main buildings, the arc lamp is adopted for general lighting, running 10 lamps in series on a 500-volt system; for all the other buildings the arc lamps are run 5 in series on a 250-volt system. The wiring of these arc lamps is so arranged that every alternate lamp is connected to a different circuit. In addition to the arc lighting of the main buildings there is also a complete pilot system of incandescent lighting, arranged so that if need arises all the principal passages, etc., can be lighted direct from the Corporation supply. The seven main cables are low-tension triple-concentric cables, insulated with impregnated paper and lead covered, laid in a wood conduit beneath the flooring between the main switchboard and the various sub-stations and switchboards, the total length being 4,000 yards. The branch main cables and sub-main cables are also laid in wood conduits beneath the flooring, or run overhead upon insulators, between the sub-switchboards and the distribution fuse boards.

Such, then, are some of the main features of what one may call the outfit of an Exhibition which, with many claims to attention on general industrial and popular grounds, will be chiefly memorable for its display of machinery. But of the contents of the machinery hall it is impossible to say anything in this article, except generally that they are representative of the engineering industries of the world. Marine engineering is a large and important section to which special attention has been given, and there is such a display of ship-building models, illustrating the progress of shipping in the past century, as has never before been brought into focus.

THE MECHANICAL ENGINEERING OF MACHINE TOOLS.

By Charles L. Griffin.

Prof. John E. Sweet, in an admirable address recently delivered, spoke of the growing accord of theory and practice. This means merely that both are becoming more enlightened —practice being based upon broader knowledge of laws and principles, theory formulated after more comprehensive recognition of all the conditions. When both are fully enlightened, there can be no discord between deduction and experiment. Empiricism disappears, and theorizing becomes practical. It is from this advanced standpoint that Mr. Griffin views machine designing.—THE EDITORS.

MACHINE TOOL, taking the term in its restricted sense, signifies only a machine directly employed in the producing of finished surfaces on iron, steel, or other metals. Though dependent, like all machinery, upon fundamental mechanical principles, the class of machinery thus defined requires in its design and construction special engineering skill peculiar to itself. Many points rated as essential to success in machine-tool building are equally applicable to other forms of machinery. The refined character of engineering as evidenced below, however, both from mechanical and commercial standpoints, rates the machine tool as one of the most exacting pieces of machinery which modern engineers are called upon to produce.

Accuracy. The prime requirement of a finished surface is accuracy. This depends on the accuracy of the tool which finished it, and the accuracy of the tool depends on the accuracy of its own surfaces and joints. In other words, inaccuracy in the finishing tool will cause corresponding inaccuracy in the surface which it produces.

Manual dexterity by the toolmaker is essential to the production of true surfaces, but ultimate success is only assured when every facility is afforded him by the design, not only to produce a true surface, but to guarantee that it will stay true under conditions of use. This calls for a design of extreme stiffness, long wearing surfaces, strains taken in direct lines, firm and rigid supports, and careful adaptation to best modern shop processes. Accurate alignment and true surface, judged by the steam-engine, pump, or hoisting-machine standard, fall below grade when applied to the machine tool. Yet it is good engineering to save such expense as unnecessary refinement will entail, and it is good design to figure on a grade of machine which corresponds to the grade of work it has to do. There is a commercial axiom, at least, which says that there is such a thing as building a machine too well, and the engineer who does not heed it is, in the present day of competition, out of the race. This same principle, which allows rough work on the steam pump and free fits on the engine, insists upon unqualified accuracy in the machine tool. Money invested in inaccurate tools is worse than thrown away; it is an investment which pays negative interest as long as the tool is operated. The manufacturer who designs and builds tools which produce curves when they should produce planes, and vice versa, is worse off than the buyer of them; in fact, his business must ultimately cease to exist. The keynote in the machine-tool business, to which all else is at all times tuned, is accuracy to the highest degree that modern skill can produce.

Rigidity. To attain rigidity in a machine tool requires the consideration of at least three fundamental elements of the structural design. These are: (1), Stiffness of frame or bed; (2), Mass to absorb vibration; (3), Number and construction of joints between the work and the bed.

Stiffness of frame is demanded to avoid springing under the strain of the work. On account of the universal nature of the tool, the strain is seldom capable of exact determination as to its magnitude, but almost always as to its direction and character. Therefore the correct distribution of metal into ribbed, box, or cylindrical sections should follow careful analysis of operation. Though no precedent be at hand to determine thickness of metal, close study of the severest conditions of service and good judgment will settle this point to a reasonable degree of success. Subsequent addition or subtraction of metal found necessary by experiment can readily be made by slight change in the pattern, provided the general plan of the structure be right, but not otherwise. Hence the necessity for correct analysis of form, if not of strength.

Concentration of mass close to the point of application of the work is on the same principle as the anvil between the blacksmith's hammer and the foundation. The absorption of tremor and vibration at the proper point by a sufficient quantity of material is the only guarantee of exactness in the work produced. Firm, solid foundations, though essential, cannot alone correct a vibrating and trembling machine. Experience seems to be the only guide for the determination of the proper amount of material to secure steadiness, but perfection is possible only when based on truly scientific study of the principles involved. Correct deduction from experience is one of the highest functions of true engineering. The design of grinding machinery, in its full modern refinement, well illustrates this point. This class of machinery has very light work thrown upon it, but the high wheel speed, tending to vibration, and the exactness of size which must nevertheless be maintained in the work, make the element of steadiness of primal importance, so that the grinding machine is probably of greater weight in proportion to the work it has to do than almost any other tool. The marvelous accuracy possible with the modern grinding machine witnesses the success with which this problem has been solved.

Joints in a machine are unavoidable evils. Any joint which has motion between its surfaces, though carefully gibbed, must, of course, have some play or looseness for proper freedom of motion. The piling up of one slide upon another in order to secure various directions of motion integrates or adds up the looseness of the joints and endangers the rigidity of the machine. The knee of the universal milling machine, with its slides, swivel table, and platen, is an example of this piling up of joints, yet it has been refined to such a degree that it produces good work in spite of this inherent mechanical defect. The increasing use of the plain milling machine, however, on account of its few joints, simple parts, and general rigidity, is evidence that universality is always ready to be sacrificed to simplicity, when duplicate processes will warrant. Few joints, so arranged that the load of the work tends to press the surfaces together rather than to pull them apart, carefully gibbed, and fitted with scrupulous exactness, sums up the utmost we can accomplish toward the absolute elimination of undesirable motion due to joints.

Adjustment. Ability to keep an originally accurate and rigid machine perfectly in that condition until worn out, by taking up the unavoidable wear, is a requirement no other class of machinery has to meet to the same degree as the machine tool. To take up wear is easy enough, but to take up the minute increments of wear as they occur, without disturbing the exact alignment of shafts or the truth of surfaces, or binding or springing parts from their normal condition, is a more severe requirement. Wear cannot be entirely prevented, and the machine tool, as a machine of accuracy, is of no use unless the wear is adequately taken up. That the adjustment must be infrequent, and, moreover, attended to by a competent mechanic, are the saving elements in the case, for perfect adjustment must of necessity be a delicate operation, though easy in the sense of accessibility and simplicity. It must be a positive, finely divided mechanism, and firmly locked when once adjusted. Ability to permit infrequency of attention is attained by ample wearing surfaces, and it is upon this one point alone that many machines excel. Though this is really dodging the issue, for to reduce the wear to an inappreciable degree is to dispense with adjustment, yet good engineering is as much the elimination of injurious action as it is the compensating for it when it is unavoidably present.

The protection of wearing surfaces thus becomes an element of adjustment, making advisable the application of guards, covers, and shields. These prevent metal chips, dirt, and other abrasive material from injuring surfaces or clogging the machine. Sometimes this feature becomes a special study, as in the case of the grinding machine already referred to. Here, not only the particles of emery from the wheel, but, in the wet type of grinder, the flow of water, which drenches the work, must be kept from the guiding surfaces. An inspection of a modern grinding machine will indicate the degree of ingenuity and skill with which these protecting devices have been worked out.

Lubrication. Good lubrication, a prime requirement in any machine, tends to be slighted out of all proportion to its importance. The method and detail of lubrication are too often worked out in accordance with space which happens to remain at the end of the design. The scheme of oiling then becomes an appendage, a patch on the machine, a collection of twisted pipes, pursuing tortuous courses to inaccessible bearings, or nobody knows where. The fault of poor lubrication may be laid almost wholly at the door of the original design. The fact that the operator allows his machine to run dry is inexcusable for him, yet in most cases the designer may be shown to have fallen far short of his duty to the machine and its operator in the scheme of lubrication. Proper oil caps can be provided, oil channels made ample and direct, oil pipes straight for ready cleaning, oil openings accessible and visibly indicated. While no machine can with advantage be built around a system of lubrication, yet it is possible so to keep in mind the future flow of oil to bearings and surfaces, that at all times in the progress of the design this element shall in a measure control their arrangement. If a bearing cannot be freely reached by oil, then it, or the obstructive member, must be re-located.

A fine, accurate machine tool is, least of all machines, the one upon which to risk scanty lubrication. Expensive in first cost and repair, expensive in the delay its crippling causes, money invested in refined and positive oiling arrangement will return high rate of interest. If repetition of this were capable of impressing the importance of good lubrication more strongly upon those careless in this respect, then it should be a never-ending chapter with the subject begun anew on every page.

Convenience. A tool is an investment, the interest which it earns depending on the amount of work which it turns out in a given time. This depends largely on its convenience of manipulation, involving a study of levers, handles, wheels, knobs, auxiliary devices, etc., their shape and location with reference to best adaptation to the average human frame, the ease and extent of their motions, and the rapidity with which these motions may be accomplished. The position of the operator, his natural tendencies, the motions he will go through, all have to be imagined, in view of the attainment of maximum convenience. This study, in the absence of any counterpart of the proposed machine, often forces a resort to rough models, or in lieu of this, a full-size blackboard sketch, extending to the floor, upon which the location of parts may be tried for convenience.

This study of convenience is not a sentimental one. It is a strictly business consideration. A workman cannot be educated to use unnatural motions. A workman who likes his machine, who can handle it easily and with natural motions, will not only get the maximum amount of work out of it, but will himself constitute the best possible advertisement for its manufacturers. You never saw a workman who made a big record of work on a tool, who did not boast of it, not on the ground of his personal dexterity, but on the ground of his personal pride as operator of a fine machine. You never saw a workman who had to make a lot of false motions to operate his machine, and whose anatomy and limits of power and motion seemed to be totally inadapted to the tool in front of him, who did not curse it and its makers thrice over to any that might listen. Such negative advertisement does not always fall on heedless ears, and it is decidedly worth while, from a commercial standpoint alone to try a little "convenience" in the design to stop it.

The introduction of the ball-bearing upright in the radial drill, and the feed gear box on the lathe, are instances of legitimate and successful attempts toward increased convenience to the operator. True, they constitute time savers, but when originally brought out, their builders enjoyed special prestige because, from the selling agent to the operator, the convenience and intrinsic worth of the device were at once apparent. This was not sentimentality; it was business. It was commercial machine tool design, a mechanical interpretation of convenience, redounding to the satisfaction of both builder and user.

Capacity. A universal tool implies capacity to take a wide range of work. It is manifestly unwise, however, to sacrifice stiffness, neatness and closeness of design, ease and facility of handling, for the sake of extension of range far beyond the average for which any particular size of tool is designed and best adapted by reason of strength, speed, or space occupied. Advertising purposes are often the sole object of such extension. The fact is that the manufacturer can build better, and the purchaser buy cheaper and to better advantage, if an extravagant attempt is not made to secure extreme range in any given tool. It is probably true that the experience of most tool builders has been to increase the number of sizes manufactured, and less and less to try to build ordinary machines for extraordinary work. However this may be, the planning and construction of a tool which can be handled with equal facility on all the varying sizes and classes of work within its range is no sinecure. Not only the average and common, but the special and unusual, must be provided for in universal tools. The ease and facility with which most of our common machine tools lend themselves to the finishing of difficult, special, and irregular shapes, is not accident. It is a forcible commentary on the past observation, ripe experience, careful study, and planning skill of the men behind the design. Credit is scantily given for such excellence, but criticism is freely furnished if a so-called universal tool, by its limitations, proves it to be absent.

Belt Power. Most machine tools are driven by belt, and the time is yet far off, if it ever comes, when the belt will be entirely superseded. Sufficiently wide belts to transmit the necessary power with comparatively low tension are conducive to long life of both belt and machine. An under-belted tool is reasonably sure at some time to have its belt pulled up to drive an increased feed and heavy chip, perhaps greater than it was designed for. However, there still remains something of a safety element in the limit to which the belt can be strained. The over-belted tool may drive itself to ruin unless provision be made for this by the introduction of purposely weaker parts to save the main and more expensive pieces. Perhaps the tendency nowadays is toward wider belts, with the idea that the user of the tool should be given the opportunity of subjecting it to overload at his own risk. This, it would seem, he is usually ready to take, and, to the credit of the tool be it said, the attempt is almost always attended with success.

Direct Power. The mechanical-engineering status of the direct electric-driven machine tool seems to be based purely on the question of expediency. This status is not likely to be soon changed. The mere elimination of the belt does not seem to warrant the application of direct power in all cases. The possibilities in the line of simplicity, range and sub-division of speed, when associated with the elimination of the belt, are legitimate objects for accomplishment by the direct electric drive. The theoretical possibilities seem to be unlimited. Practically, the complication of the electrical controlling mechanism to secure required fineness of gradation is a difficult and often prohibitive problem.

Though the many good forms of the enclosed type of motor lend themselves readily to the service, yet that the motor and controlling devices may not be excrescences on an otherwise shapely tool requires considerable skill in harmonizing lines and method of attachment. The golden time when the motor and the tool shall not be the product of different shops, as at present, but shall both be wholly controlled by the tool builder, is the vision which haunts the present critic of the *ensemble* of the electric-driven machine tool.

Form and Finish. The general appearance of machinery viewed from a distance is the main criterion for judgment in most cases, except that of machine tools. In these we have a criticism of detail form and finish not applied to any other class of machinery. The general structure must, of course, convey the idea of solidity, but in addition, the careful detail of fillets, the rounding of corners, the shapes of handles and levers, the definition of bosses and lugs, the smooth regularity of surface, the finish of operating parts—all these and numerous other details must satisfy the critical eye. A single weak-appearing arm or support, though it be actually strong enough, injures the tool, and it is good policy of the builder to alter it to stop the criticism. These are not trivial things. A really good tool in other respects, but lacking in form and finish, will not sell and will not satisfy when sold. The American tool builder has won a world-wide reputation for the uniform and sensible style of his design, largely through the minute attention he has given to every detail. Aside from any other consideration, it should be a national pride to maintain and extend this reputation.

Trappiness. This coined term is used to signify a collection of details, insignificant in size, put together with a multitude of joints, the whole device being, as the name suggests, a trap, a snare, a tangle of parts. Such a device is usually the result of a roundabout train of thought; it is therefore complicated, difficult to put together and take apart, not positive in action, its parts crooked and ugly—in short, the whole device constitutes a blotch on the machine, both in appearance and operation. The avoidance of this defect can only be accomplished by an absolutely clear and direct conception of results to be attained. Impractical inventions are often the result of blindly following an intricate and tortuous path, merely for the sake of preserving the invention, when simpler ways exist. When once the insatiable desire to invent something takes hold of a man, he is in a prime condition to produce trappy devices. True invention implies simplification, not complication.

Materials. The labor of finishing the component parts of a machine tool is apt to be the largest proportion of the total cost. Considering this, and the service expected of it when finished, the best material for the place is none too good. Judgment as to what is the best material involves consideration not only of the strength and stiffness of the proposed material, but of its wearing and tempering qualities, its homogeneity, its action under the finishing tool, available shop facilities, and the most advanced shop processes. For example, the milling process cannot produce satisfactory surfaces on castings of varying quality, full of hard spots, and of irregular size due to careless molding. The excessive cutter wear, the varying depth of cut, the jumping from soft metal to chilled spots, the trouble in maintaining the feed in such cases, are points which try the disposition of the workman and make uniform and good work impossible. Drop forgings, malleable-iron and steel castings, in their late perfection of quality, ought to be a special boon to modern machine-tool builders.

Standardization. Building tools in lots, a considerable number in a lot, is, of course, the only possible way to build cheaply and at the same time well. The opportunity here offered for the standardization of parts cannot be too early appreciated in the course of a business. For the proper application of standard patterns, jigs, fixtures, and cheap methods, this question of standardization will sooner or later confront the manufacturer. The earlier the demand is realized the better, for the herculean task of doing it all after the accumulated construction of a decade or more is vastly expensive, and accomplished at a tremendous disadvantage. Its feasibilty is then only possible on account of its undisputed necessity.

The original standardization of parts rests chiefly with the designer, and on the consideration which he gives this matter is largely dependent his success and reputation as a practical man, alive to the interest of his employer and himself. It is not as pleasant or easy to design machinery of any sort with "hands tied," so to speak, to standard parts. The designer loves to let his personal fancy express itself without restriction. To be thus fancy-free is indeed ideal, but it is a luxury which must be paid for, and it comes high, and is therefore inconsistent with commercial interests. Ability to reduce designs to standard construction, allowing maximum shop production with systematic labor, and to reduce repairs and duplication of parts to the simplest system—this is true, practical, commercial engineering; the other is mechanical dreaming.

This idea of standardization applies equally to all classes of machinery. All modern refined processes tend toward it or imply its adoption. The screw machine, the turret lathe, the grinding machine, the multiple-spindle drill, and numberless other machines are all devices to cheapen and make better machine parts. For the full co-operation of these machines, however, they must be used upon standard parts, which may be produced in large quantities.

Conclusion. The mechanical engineering of machine tools involves not only mechanical proficiency, but a keen perception of the commercial and selling features of the business. Shrewd deduction from close observation, experiment, and long experience—such deduction based rather on true mechanical insight than on direct calculation—represent the attainment of the pure engineering faculty. This, it should be noted, is in contrast to the engineering involved in those larger mechanical structures, with more definite loads and service, not included in the classification "machine tools" as herein applied. In these larger structures an essentially different style of thought is predominant, a closer connection existing between the calculations of theory as laid down in the applied mechanics and the requirements of practice.

The mechanical engineer has a wide field in each and all of these diversified interests. It is due to his technical education, acquired in the engineering school, his observation and experience of actual practice, and his development of business sense, properly combined and conscientiously applied, that machinery of whatever class or variety—the machine tool or the locomotive—continues to improve, and will continue to improve with each succeeding generation.

GOLD MINING AND MILLING IN WESTERN AUSTRALIA.

By A. G. Charleton.

IV.—MINING METHODS, COSTS, AND SPECIAL CONDITIONS.

Mr. Charleton's series began in February. His preceding papers have dealt with topography, geology and general conditions, the dry-blowing process, and the water problems of the Westralian field. A concluding article will take up milling and cyaniding.—THE EDITORS.

CAPITAL, in the early history of the Westralian field, was wasted in immense amounts in sinking small prospecting shafts, and leases of only 24 acres in area were frequently dotted with half-a-dozen or more shallow pot-holes, notwithstanding the fact that the lode-formations, as a rule, are almost vertical and the surface-zone is much unsettled. Consequently, even to-day, many properties are by no means as thoroughly explored as they ought to be. The leases held by any one company vary in size from 10 to 85 acres, but seldom exceed 50 acres.

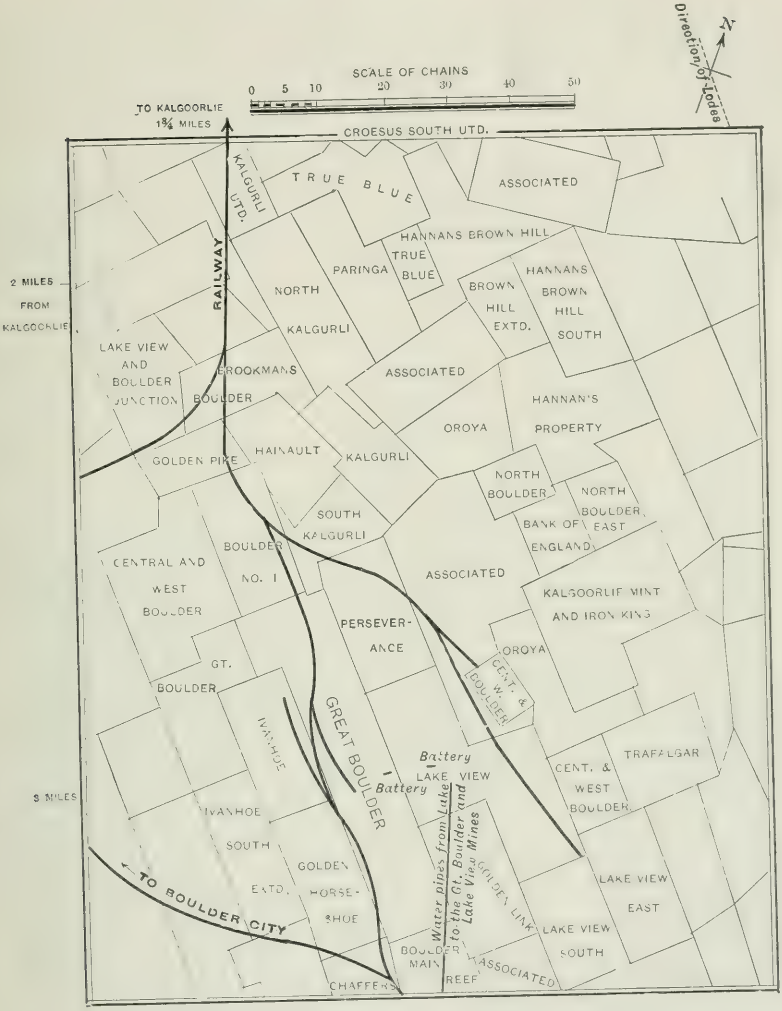
A great deal of money may easily be squandered in objectless prospecting—for instance, in cross-cutting long distances where there are no indications to warrant outlay of the kind. But at Kalgoorlie there are a succession of parallel "formations," some of which are "blind-lodes" that never reach the surface at all; moreover, the ore in the different formations occurs in large isolated lenticular masses, containing perhaps individually thousands of tons of rich ore, separated along the course of the deposits by many feet of barren ground; the ore is also split up into vertical bands by parallel sheets or horses of country rock, and is liable to be faulted off or to be found in isolated bunches in the walls. Under such circumstances, before a lease can be said to be thoroughly tested it must be properly and thoroughly cross-cut at various levels. The length and direction which such cross-cuts should take is by no means arbitary, being governed by the nature of the discoveries made on the surface, or developments underground, and by the position of a property with respect to the formations discovered in neighbouring leases—in short, by indications and rational assumptions pointing to the probability or otherwise of finding a body of pay-ore in a particular part of the ground to be explored.

Where the width of a lease is considerable, it would seem to be the soundest policy, under ordinary conditions, to sink an independent prospecting shaft for cross-cutting the shallow ground, when looking for a formation; but if considerable depth has been reached, it would be cheaper, as a rule, to put out exploratory cross-cuts from the main-shaft when in search of a blind lode, or in order to see if (as has not unfrequently happened) any improvement has taken place in depth in a formation known to traverse the lease, but which has proved more or less barren at surface.

To avoid long and expensive cross-cuts and to save time, long single bore-holes are frequently run out with diamond-drills, to cross-cut the ground, and valuable discoveries have been made in this manner; but it is rather doubtful whether such a plan is always satisfactory or pays in the long run, since the results are sometimes misleading when a formation is intersected in an exceptionally rich or poor spot. You cannot examine a section of a bore-hole as you can a drive; and even if a rich formation happens to be discovered, time and money are lost in getting at it to open it up. The conditions, in fact, are totally different to those on the Rand and in other places, where deep exploratory bore-holes have been sunk no doubt with great advantage.

Probably no better system can be employed, however, at Kalgoorlie to test the ground on either side of a drive in a wide formation than that

AN OPEN CUT AT KANOWNA.



POCKET PLAN, SHOWING THE RELATIVE POSITIONS OF THE PRINCIPAL MINES, APPROXIMATE DIRECTION OF LODES, ETC., AT KALGOORLIE.

By H. Thiébauld de la Crouée. Reproduced by permission.

of putting in a number of short cross-cut holes for distances up to 100 or even 150 feet in length. As a case in point may be cited the new discovery reported in the Great Boulder, by a bore going west from No. 2 air-shaft on Robertson's lode; an oxidised ore-body was cut, reported to be 2 feet 6 inches wide, assaying 5 ounces. During the year 1899 the Great Boulder did no less than 4,802 feet of diamond drilling, and in 1898 1,250 feet.

Boring is done on day-pay and contract, the cost varying with the size of hole, nature of ground, price of "carbons," etc.;[*] but I believe about 20s. to 22s. a foot, depending on the amount of power supplied, will cover the cost of most of the larger size holes put in up to date; whilst under ordinary circumstances and under favourable conditions, small ones can be drilled for 5s. 6d. per foot.

Development of Shafts:—Baron van Oldruitenborgh expresses the opinion that a great mistake was committed by most of the mining companies at the start, by sinking nearly all their vertical or main shafts within the hanging-wall country of the lodes, to reduce the expense of cross-cutting, notwithstanding that this item in the cost of development is liable to increase constantly with depth, if the shaft is sunk in the footwall, unless the underlie of the formation changes. It is true that the former course is justifiable in most cases, but when, as at Kalgoorlie, the formations dip generally at a very high angle, no doubt it would have been better to sink on the footwall side.

WORKINGS IN AN ALLUVIAL CLAIM, KALGOORLIE

Whilst, on the one hand, the great width of some of the Kalgoorlie ore-bodies favours large outputs, on the other the uncertainty and irregularity in the distribution of the ore (more particularly in some of the formations) operates the other way, making medium outputs the rule, for the time being. Hence the powerful but necessarily costly installations for winding purposes which are common on the Rand would, even in its present stage of development, be money thrown away in Western Australia—a point which adverse critics of Westralian management seem to overlook.

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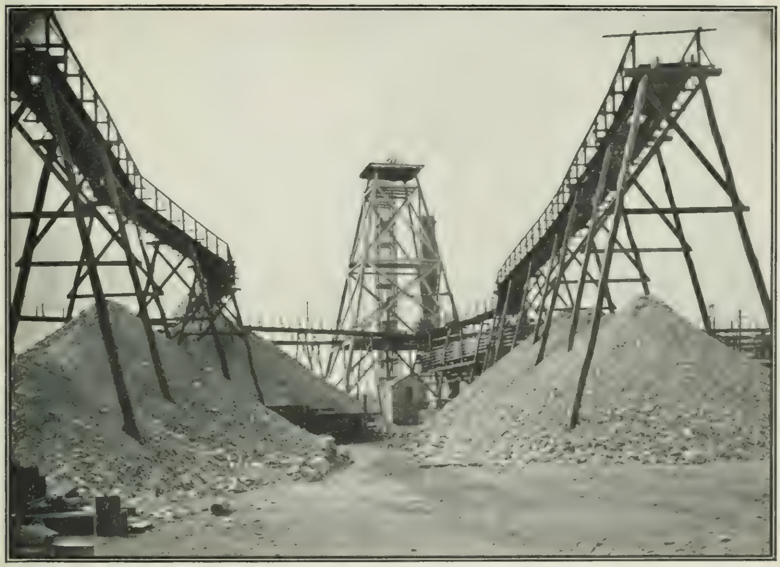
[*] "Technical Observations upon the Coolgardie Gold Fields." London *Mining Journal.*



HEAD-GEAR, SHAFT, AND DUMPS, GREAT BOULDER MINE.

The winding plant at the Great Boulder main shaft, Mr. Hamilton informs me, consists of a first motion horizontal engine, with a pair of 14-inch cylinders, 3-foot stroke, and 6-foot drums, steam being supplied by a set of 6 feet by 24 feet Cornish boilers. The pulley-frames or "poppet-legs," are of karri timber, the legs consisting of four single sticks of round timber, whilst the rest of the framing (which is 85 feet in height) is of sawn timber, carrying a landing-stage for the mine trucks at a level high enough to give good dump-room. At Lane's shaft the engine shed contains two pumps with compound cylinders, 9 inches and 16 inches diameter, and 12-inch water cylinders with a 15-inch stroke, which are used to pump the salt water required by the mine to the top of the hill behind the present mill.

I am indebted to Mr. Hewitson for the information that the Ivanhoe main shaft is equipped with an 18-inch by 42-inch first-motion engine, with 8-foot drums, and in the engine shed at Drysdale's shaft, which is fitted with an 8-inch Cornish lift pump, operated by an 18-inch by 42-inch engine, they have also a geared 12-inch by 30-inch slide-valve engine with 6-foot diameter double drums. The head-gear at the winding-shaft consists of iron poppet-legs, 60 feet high, which were to be replaced by wooden legs 95 feet high; but I understand that the substitution of steel framework has since been decided upon. When tarred and set in solid blocks of concrete (a plan I introduced at Charters Towers, Queensland) wooden legs are perfectly safe from the attacks of white ants,, which are sometimes suggested as an objection to their use.

At the Lake View, the four posts of the main frame-work are set vertical and strutted with back-stays; but the legs of most of the head gears are spread outward, requiring no back struts with the engine set close to them.

As fuel and condensed water for use in boilers are both expensive items, high-pressure boilers are generally employed, and the exhaust steam is usually condensed either in galvanised-iron coolers, made of annular rings about 8 feet in height and 3 or 4 feet in diameter (a crude form of condenser) or in surface condensers of the Wheeler class. Lately, however, Fouche's aëro-condenser has been introduced.

At the end of 1899, the depth in feet reached by the principal main shafts as given in the *Statist*, were as follows:

Associated G. M. Co. Tetley's Shaft (Australia Lease), 500.
No. 4 Shaft, "Adelaide" lease, 700.
Chaffers, 500.
Golden Horseshoe, 505.
Golden Link Consols, 800.
Gt. Boulder Proprietary, 900.
Gt. Boulder Main Reef, 400.
Gt. Boulder Perseverance, 536.
Hannan's Brown Hill, 498.
Ivanhoe (Patterson's), 500.
Kalgurli, 420 ft. (winze to 520).
Kalgoorli Mint, 500.
Lake View & Boulder Junction, 607.
Lake View Consols, 500.
Lake View South, 768.

At the end of June, 1900, the Golden Link was down to 900 feet, and the Great Boulder Proprietary to 1,000 feet, these being the greatest depths so far reached on the field.

It must be confessed that, considering the age of the field, these results are by no means extraordinary, and some properties would undoubtedly have benefited by more energetic development in depth; but on the other hand, various mines have developed reserves of sulphide ore considerably in advance of their immediate requirements, and no doubt have been awaiting settlement of the water and sulphide difficulties before inaugurating a more active policy of development.

Interesting from a general mining stand-point as proofs regarding the permanency or otherwise of the telluride formations in depth might be, no doubt no one felt particularly anxious individually to face the

THE IVANHOE MINE, SHOWING HEAD GEAR AND DUMPS.

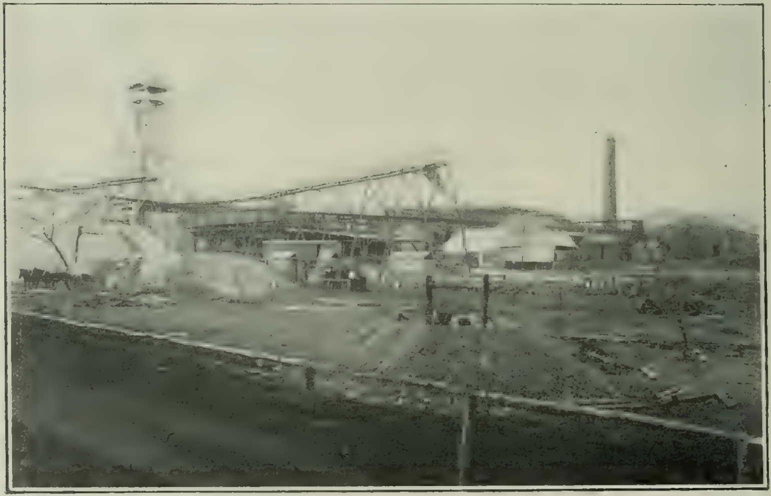
lions in the Stock Exchange arena earlier than was absolutely necessary, and not unnaturally everyone preferred to leave that honour to somebody else. Mr. Hamilton, of the Great Boulder, and other managers, however, with commendable nerve, acting under the conviction that the formations would hold down, led the way where others feared to tread, for which they are now reaping well-deserved credit.

Shaft Dimensions and Speed and Costs of Sinking. Mr. E. P. Simpson states that the main shaft of the Associated, 10 by 6 feet in

HANNAN'S BROWN HILL MINE.

section, was sunk 32 feet through hard diorite in one week, and I am told that the Lake View & Boulder Junction shaft was put down between the 200 and 520-foot levels at an average of 60 feet a month under Mr. Frank Grace, the best record being 44 feet in 12 days. These, so far as I know, are about the best records so far that can be shown; but, as a rule, it may be said speed in shaft-sinking is not very rapid when compared with the Rand,* and even with other places in Australia.

Whilst reasons that may account for this have already been explained, the slow rate of sinking is to some extent due to want of skill on the part of some of the men employed, few of whom possessed experience in machine work in the early days of the field. It is partly attributable also to the blue ground probably being harder in depth than the Rand sandstone and quartzite formations; again, the comparatively small size of the principal shafts militates against record speeds. They are frequently (unless mere prospecting shafts, which are mostly 8 by 4) 10 feet by 4 feet inside lining timbers, and an ordinary contract price for sinking and timbering, covering labour only, runs about £5 a foot.*



ANOTHER VIEW OF THE GREAT BOULDER PROPERTIES.

It will however be seen that although the rate of sinking is slow,

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* The rate of sinking in South Africa commonly runs from 60 to 96 feet per month, and as high a rate as 141 feet a month was reached in December, 1896, in the Vogilstruis deep vertical shaft. In a deep Queensland shaft I have myself made speeds in hard Charters Towers syenite, varying from 63 feet to 72 feet per month, timbered, at a cost of about £11.10.6 a foot, including everything. This shaft was laid out and started 14 feet by 3 feet 6 inches before I took charge; had it been a handier shape I think, moreover, the above speeds could probably have been exceeded

(and one reason for this has been that sinking and development have generally gone on concurrently) these small-sized shafts are far less expensive to sink and equip than those on the Rand, where many of the main shafts cost from £15 to £31 per foot, and more—an outlay justified in that case no doubt, however, by the paramount necessity that exists to provide for a large output, to open up a large area of ground in depth from a single shaft with the utmost possible speed, to provide space to allow of proper ventilation in depth, as well as to give room for air-pipes, etc., in the pump and ladder-ways.

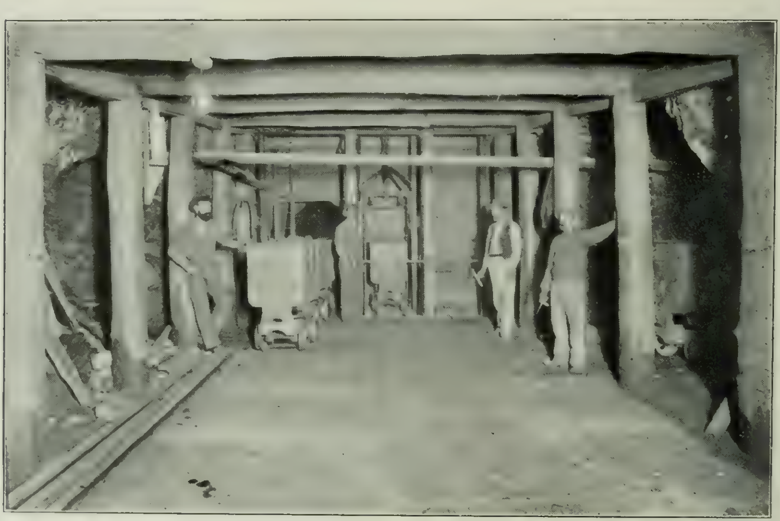
Some of the West Australian shafts, like those I have referred to, are "box-lined" for the sake of cheapness, like most Queensland shafts; in other cases, as at Lake View, where the ground is perhaps heavier, square-set timbering is used, with "lagging driven behind the wall, and end plates."

There are no underlie shafts at Kalgoorlie, owing to the vertical dip of the formations.

Shaft Equipment:—Owing to the small size of the shafts, the average weight of ore raised at each hoist is only 7 cwt., as compared with 4 to 16 tons hoisted at one operation at Johannesburg; in Australia the hoisting is commonly done in cages. There is no doubt that this method of hoisting possesses distinct advantages in collieries, but in metal mines it is questionable whether in a suitably arranged shaft, with underground plats for storage, preference should not be given to self-dumping skips, holding 3 tons or more, such as are employed on the Rand: they save weight and the services of brace men. They can be carried on frames running along the shaft-guides, and a common size in Johannesburg is about 30 cubic-foot capacity. One advantage also of a skip-road is that a water-tank can be employed for bailing, if there is no great quantity of water to be raised.

The single-deck cages carrying the trucks are fitted with the ordinary safety appliances and with hooks to prevent overwinding, and are balanced in the two hoisting compartments of the shaft by leading the winding ropes over one drum of the engine and under the other. The end-tipping steel trucks used underground measure in some cases only 8 cubic feet (holding 6 or 7 cwt., with a tare of about 2½ cwt.); in other cases they hold 10 cwt., and at Great Boulder they have a capacity of 13 cubic feet, which from the point of view of economy in haulage and transport is a step in the right direction; the pattern I saw in use, however, in one or two mines, struck me as somewhat cumbersome, and likely to give trouble if a truck became derailed in a level.

At the various levels, plats are chambered out the height of the opening-out set for the full width of the long side of the shaft, and carried straight in, or sloped up from the drive, which is commenced about 20 feet or so beyond. The floor is boarded and covered with flat-sheets, and they are lighted in some cases with electric glow lamps, and in other cases, as at Great Boulder, with oil-lamps. Plats of this kind cost about £7 a foot to drive. Pumps are but little needed, it being generally possible to dam back most of the water which comes from the surface in the upper levels, and syphon it off into skips or water-tanks. Nasty sores are caused if men are much exposed to the salt underground water.



PLAT, 200-FOOT LEVEL, LAKE VIEW CONSOLS MINES.

Air-Compressors and Rock-Drills:—In the soft upper ground, hand labour was necessarily extensively employed. In the hard igneous rocks, machine work is however undoubtedly not only the cheapest but a necessity if rapid progress is to be made, although the schistose and jointy structure of the rock at times gives trouble with the drills "fitchering." These facts explain why the introduction of machine work on the field has not been more general and rapid.

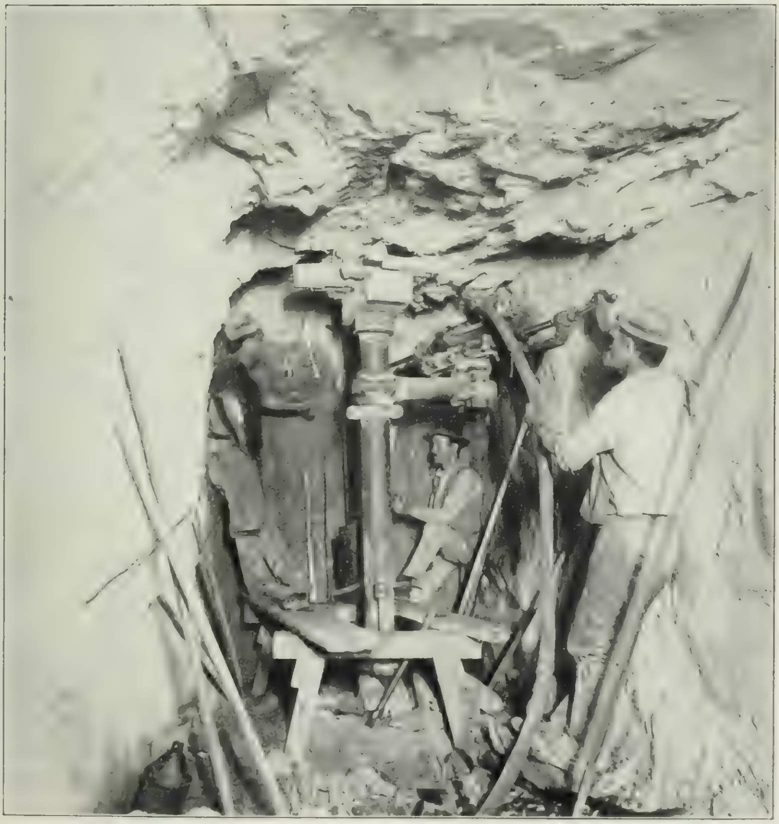
The ordinary air pressure used at most of the mines varies from 70 to 80 pounds per square inch, but there seems no reason why, given suitable machinery, higher pressures of 90 to 100 pounds should not be employed to accelerate speed.

Rand 3⅛-inch and Ingersoll-Sergeant 3¼-inch drills are most in favour on the field, the latter giving very satisfactory results; but Mr.

Hamilton informs me that at the Great Boulder they use both Ingersoll-Sergeant, and Bendigo 3¼-inch machines, and find them equally efficient. I have no information as to where the Climax, which is largely in favour in India, or other types of drill in use elsewhere, have been tried. Compressed air is used to operate air winches and small pumps underground at times, but pumps are expensive to operate in this way.

Drives and Levels:—In most of the mines the levels are run 7 by 5, and are driven at intervals of 100 feet or less, connected by rises and winzes, passes 4 by 4 in the clear being put up about every 50 feet, timbered with 8-inch by 2-inch sawn timber, and closed at the bottom with sliding doors.

In machine drilling, about 18 holes are drilled in the face, to a depth of 4 feet or so, the centre ones converging, and the outer ones radiating at an angle outwards, so as to square-up the face, in the usual manner.



MACHINE DRILLS AT THE FACE, [illegible] FOOT LEVEL, LAKE VIEW CONSOLS MINES.

3⅛-inch and 3¼-inch star or cross bits are used in driving on the lode, and chisel-edge bits in cross-cutting. The employment of machine-drills increases speed, but according to various managers makes little difference in cost per foot.

The cost of driving levels in the softer oxidised formation by hand may be ordinarily reckoned I believe at £1.5 to £1.15 per foot, though it can sometimes be done for less than 20s. In the lower levels the cost of driving with machines at present comes to about £2.10 per foot, including explosives and sharpening drills. At one mine, according to Mr. H. F. Bulman*, they give a bonus to each man of £1 per week if 16 feet is exceeded, whilst at another £2 a foot extra is paid for rates exceeding 19 feet a week. Drives of ordinary size, 7 by 5, used to cost £2.5.10 to £3.6.8, according to Bancroft, whilst Hoover figured the cost of driving and cross-cutting in 1898 at from £2 to £6. Mr. Bulman states that a cross-cut 7 by 5 was driven 40 feet in a fortnight by 6 men (2 per shift) with machines, doing their own trucking to the shaft, 500 feet. He adds that in levels in hard sulphide ore, 12 feet a week is considered a fair rate of speed with 3 pairs of men, drilling by hand.

I am told by Mr. Hewitson that at the Ivanhoe Mine they reckon 85 feet an average rate of progress per month in levels driven with machines. Mr. Hamilton, of the Great Boulder, puts the average length of holes drilled per shift at about 50 feet, varying with the rock. It will be seen therefore that the speed of driving, as might be expected, compares more favourably than shaft sinking with the Rand, where the average rate of progress in driving levels is something over 100 feet a month, but existing rates might probably be improved upon in Kalgoorlie by adopting a squarer section of drive with its greatest width in the middle, and giving greater attention to the method of placing the holes, so as to obtain the same effect with a smaller number, say 14, the face being apt to be burnt instead of blasted out, if an excessive number of holes are put in. Mr. Hoover reckons that the cost of driving in Western Australia (presumably including everything) varies from £2 to £9 per foot, of which about 80 per cent. goes for wages.

Explosives:—These consist, according to Mr. Hamilton, of Nobels Glasgow gelignite, blasting gelatine, gelatine dynamite, and red dynamite. They cost from £3.1.6 to £4.8.6 a case, nearly double Glasgow prices *plus* freight. There is said to be a ring in dynamite, although it certainly costs less than in South Africa, where the dynamite monopoly has long been a notorious scandal and grievance.

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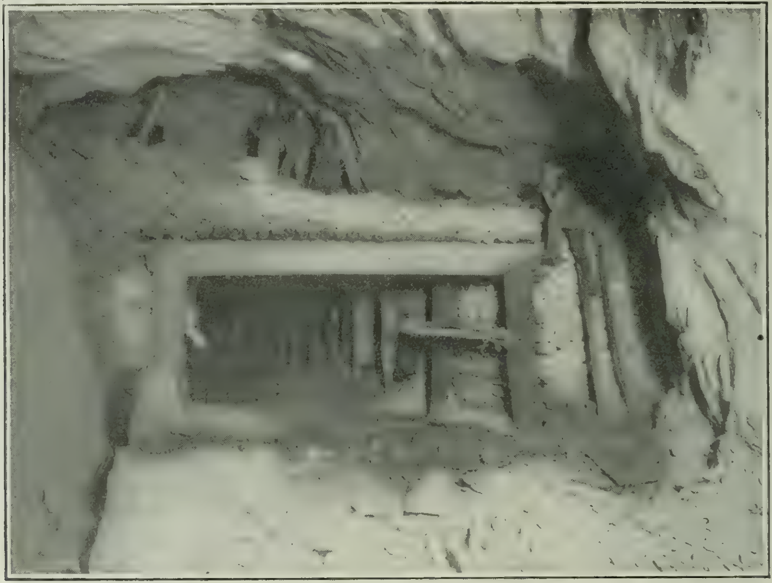
* Trans. Inst. of Mining Engineers.

LAKE VIEW CONSOLS. FACE OF RICH TELLURIDE ORE, 300 FEET

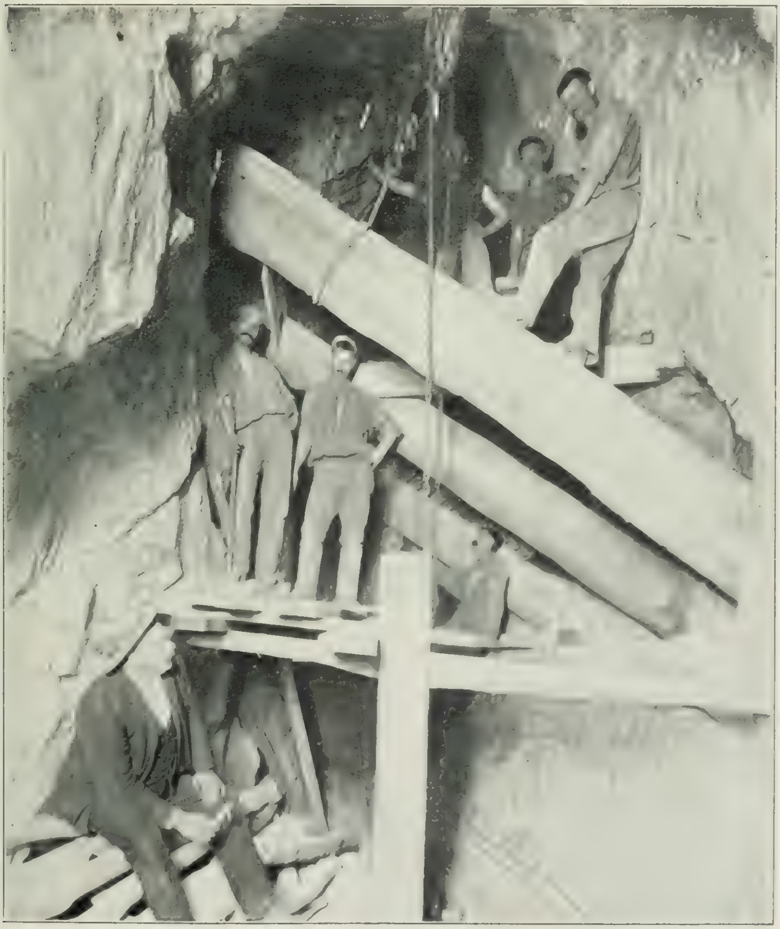
Timber:—Good mining timber is very scarce; and whilst native woods such as jarrah and karri, which are found along the coast, are largely employed underground, more particularly if required in long lengths, for various reasons they are not so much used for general purposes as Oregon pine, which costs about £12 per thousand, delivered along the railway. The native woods are brittle, double the weight of pine, shrink greatly, and are very difficult to work, carpenters' tools requiring to be specially tempered for the purpose.

Stopes:—Overhand stoping and rock filling is the method almost universally employed in removing the ore, but it is more than probable that in the wider ore bodies a considerable saving in expense might be effected by cross stoping them, on one of the systems employed in mining very wide deposits. The only novelty in practice in this respect that has come under my notice is the plan that was first adopted at Lake View, of running the waste tailings from the cyanide-vats through surface passes into the stopes for filling. At first this produced a very injurious effect on the men, owing to the cyanide left in them, the fumes of which, in badly ventilated parts of the workings, caused the miners to suffer from dizziness—in fact from poisoning in a mild form. To overcome this trouble the tailings are now washed with water before being sent underground; but unless washed with a cyanicide, such as sulphate of copper, which would be expensive and inconvenient, it seems open to question how far this treatment ensures safety. It is also said that in some instances the tailings contained sufficient gold to make it rather an expensive matter. Moreover, it appears doubtful, unless pack-walls or pigstyes filled with rock are used in conjunction with sands, whether the latter even when dry form by themselves a safe packing for wide stopes, although they are reported not to run as freely as one would expect them to do. The dryness of the stopes no doubt diminishes the danger of water charged with cyanide finding its way down into the lower levels, as it would in a wet mine.


TIMBERING AND ROCK FILLING IN AN AUSTRALIAN GOLD MINE.

If tailings can be safely employed on a large scale, this method certainly seems to achieve two useful objects: First, getting rid of surface accumulations, which are liable to block up leases of small area inconveniently; and second, obviating the expense of driving cross-cuts underground and quarrying mullock for filling, as sometimes has to be done. I may add that it appears probable that one of the directions in which mining costs will be most cheapened hereafter will be by the use of light machine drills in stoping these wide formations.

Timbering:—So long as the levels in the sulphide zone are kept narrow, they require very little timber; but when they are reached by



TIMBERING, LAKE VIEW CONSOLS MINES

the stopes from below, and the full width of the lode comes to be removed, the case is different; the caps and posts, which are of round timber, frequently run up to 15 inches in diameter, forming four-piece sets (that is to say, with a post in the middle) where the width is great.

Sometimes a line of posts is set to one side of a level, forming a man-way, with a double line of rails laid on the other and wider side; and in the Kalgoorlie mine a kind of saddle-back system of timbering is employed, consisting of stalls fixed opposite one another in hitches in the floor, butting like the rafters of a roof against a central longitudinal ridge-piece under the centre of the back of the level; the triangular spaces behind, on each side, are packed with mullock resting on lagging.[*] The idea is to economise timber.

For ordinary stulls and in levels which do not require massive timbering, 8-inch timber is used. The salmon-gum, which grows plentifully in the district, makes the best mine timber, it is said, becoming so hard that holes cannot be bored in it by hand.

In the stopes, posts with head-boards and cribs or pigstyes are employed to prevent caves, and the timbering and filling of the stopes is one of the main items of cost in mining in Kalgoorlie; in fact, Mr. Hoover[†] states it costs as much as the actual breaking and handling of the ore. The cost of timber at the Lake View Consols in 1898, for instance, amounted to £13,661.5.2, or 4s. 8d. per ton raised and treated; but of course a large part of this is chargeable to development.

Tramming:—Men are employed in trucking exclusively, but Mr. Hamilton informs me that they propose to use horse traction in the lower levels; I am not aware whether the merits of electric traction for such a purpose have been compared with it or not; but animal or mechanical haulage seems capable of profitable application only where the main levels are fairly straight, of exceptional length, and of suitable size. At the Great Boulder, the main drives are laid with steel rails, with a 17-inch-gauge track. At the smaller mines, if the roads are long, the cost of trucking is necessarily high. It might no doubt be cheapened by better organisation in some cases, 9 to 10 tons per man per shift, including stone broken in development, being reckoned, I believe, a fair day's work, which represents a cost of 1s. 1.33d. per ton shifted. This means that on a small output trucking is liable to cost 1s. 6d. or 2s. per ton of ore milled, taking into account the stone shifted for filling.

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[*] See the *Engineering and Mining Journal,* August 18, 1900.

[†] *Engineering and Mining Journal,* Dec 17th, 1898.

Ventilation:—Is entirely natural, and is assisted by the difference in temperature between the surface and below ground.

Lighting:—As already mentioned, the plats are lighted by electricity, or large oil-lamps; but since the question of safety has no bearing on the matter, candles are mostly employed underground, and just as the Saxon miner in the silver-lead mines still clings to his *blende*, so the Australian, like the Cornishman, as a rule prefers his dip thrust in a lump of well-kneaded red clay, or an American steel candle-holder, which he can stick or hang anywhere. As either oil or tallow would, if dropped amongst the ore, seriously interfere with amalgamation, and might cause loss of gold out of all proportion to the saving effected by the use of a cheaper illuminant, stearine, paraffin, or composite candles are generally employed.

A GROUP OF NORTH COOLGARDIE BLACKS. NOT AVAILABLE FOR MINE LABOUR.

The cost of illumination, as might be expected, is less in stopes than in levels, reckoned on the tonnage broken; but the light being more diffused, and exposed to draughts, more candles are used per man.

Sorting:—On the Rand, Truscott points out that there is a direct saving of gold effected by sorting, in addition to a saving in reduction expenses, as the waste sorted out often does not assay 1¼ dwts., whereas the residues from reduction works generally assay more. If therefore the waste, instead of being sorted out, were crushed and treated, it would arrive at the residue dumps, with a higher assay value than it originally had.* The capacity of the mills and reduction plants is also increased proportionately to the amount of stone thus got rid of, and the waste sorted out underground saves expense in providing mullock for packing the stopes.

In Kalgoorlie little or no sorting is attempted, and the justification for this lies in the fact that, unlike ore on the Rand, it is frequently impossible to distinguish between a piece of ore in gold and a bit of mullock. There is no doubt that the ore brought to the surface, owing to insufficiency of light underground and the dirt and smoke with which much of the ore is covered, carries a considerable proportion of waste. If this could be got rid of, it would be of distinct advantage, but what little sorting is attempted at Kalgoorlie is done merely on the dumps. To do it properly would involve the erection of elaborate washing and sorting plants on the surface, and put temptation in the sorters' way.

It is doubtful, therefore, whether the loss and cost would not greatly exceed the gain, unless the distinction between rich and poor ore becomes more marked in the lower levels of some of the mines, as may perhaps happen; in which event, surface sorting with adequate safe-guards will become a question for serious consideration.

In some mines there is, however, a good deal of barren stone, which might possibly by more careful attention to the progress of developments be separated underground, saving the expense of raising it, and leaving it where it would be most useful for filling.

Sampling:—I do not think I am wrong in stating that sampling an ordinary quartz vein, or Johannesburg banket, is child's play compared with the difficulties of sampling the Kalgoorlie formations.

When you come to consider the following facts:—(1), That ore until it is assayed is frequently indistinguishable from mullock. (2), That the ore varies in width as much as it does in value, possesses practically no well-defined walls, and is at times payable over great widths. (3), That minute seams of rich telluride are apt to run through it in all directions, bringing up the value of a foot or two of otherwise almost worthless stone to a payable grade. (4), That a given width of formation, owing to patches of rich telluride, will alter in average value from a few pennyweights to 20 or 30 ounces to the ton, in a run of level not exceeding a few feet in length—it is evident that the question of accurate sampling is a very different affair to sampling a well-defined deposit, with values as a rule fairly evenly distributed through it.

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* S. T. Truscott, "The Witwatersrand Gold Fields," p. 409.

By sampling the drives at regular and close intervals, as they advance, and taking check samples from the passes and trucks delivered on surface, an approximate idea can, no doubt, be formed of the value of a block of ground, but it is practically impossible to figure with absolute certainty what any large block of ground will yield until it is actually stoped out, as it is apt to contain surprises, equally as pleasant as otherwise, in the shape of unexpected bunches of rich telluride which set the most careful calculations at defiance; and however great the sampler's experience, care, and rectitude may be, he is liable to make unavoidable mistakes in estimates of the kind based on ore in sight, using the term as ordinarily understood.

The foregoing facts may possibly in some measure explain the startling discrepancies that have occurred in estimating ore in sight. A most notable case was one in which, according to the chairman of the company, the late manager calculated the reserves of one of the principal mines in August, 1899, at 739,296 tons, valued at 1 ounce 16 pennyweights, whilst mining engineers who inspected the property in April, 1900, reported only 37,740 tons, valued approximately at 1 ounce 8.33 pennyweights. The difference in this instance is quite incomprehensible.

Developments Underground:—Sufficient has been said, however, to show that in order to maintain a large output, with a regular mill-average, whilst adding gradually to reserves, it is even more necessary in some mines than in others to keep development work pushed well ahead at different levels. The following tables, compiled from official reports, giving the records of four of the mines of the field in 1899, illustrate this:

Scale of Treatment. Tons.		Authority.	Year.	Est. Ore Reserves, Dec. 31st, 1890. Tons.	Sunk, Feet.[*]	Driven, Feet.	Cross-cut, Feet.	Total Feet.
59,664	Ivanhoe	Co.'s Rep.	1899	Oxidised, 128,273 Sulphide, 83,600 Total, 211,873	1,436	3,371	1,542	6,349
85,889	Lake View	do.	1899	Sulphide, 304,800[†]	1,235	3,221		4,456
72,865	Gt. Boulder	do.	1899	Oxidised, 17,266 Sulphide, 131,878 Total, 149,144	2,579	5,195	1,750	9,524
11,534	N. Boulder	do.	1899	Sulphide, 5,000	1,222	1,488	1,419	4,129

If rises and winzes are included, the general average cost of development, according to Mr. Hoover, has been about 4s. 6d. ($1.08) per ton of ore developed. As he adds, however, "this figure must be taken with a grain of salt," the cost being liable to be largely increased by the necessary prospecting work in cross-cutting, etc., looking for new ore-bodies. Were it not for this, the development of a given tonnage of ore would be quite a cheap item, and the drivage on the actual ore-bodies could be kept at a comparatively small figure, without fear of reserves falling suddenly short.

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[*] Shafts, winzes, and rises.

[†] Exclusive of oxidised ore, of which no estimate is given, but reported to be a large amount.

Mr. H. C. Hoover* states that one of the most difficult problems in the West Australian mines is the inefficiency of the labour (wages representing, he reckons, about 80 per cent.† of the cost of sinking and driving). It is true, he adds, this is improving with time, but even now the amount of work accomplished per man per day is astoundingly small. In one mine the men stoped quartz, in a body 20 feet wide, at the rate of 1.8 tons per man per diem. In another mine, in soft lode matter under best conditions, 2.7 tons per man per diem. It may be added that each foot of thickness of ore (reckoning it at 12 to 14 cubic feet to the ton in place) may be estimated to yield 2½ to 3 tons per square fathom (6 by 6) stoped.

Surface Haulage:—Several of the mines at Kalgoorlie are connected by siding with the Government steam tram-line, but drays and horse teams are still extensively used, and overhead tramways on trestle work, operated by manual labour, are laid to the mullock dumps.

At Lake View, the ore broken in the stone-breaker is raised from storage bins at the main shaft by an endless wire-rope way to the top of the mill; at the Lake View South, the mill which stands on a hill is connected with the main shaft in an ingenious way, by a tramway laid on trestles, set at such a grade that the trucks landed on the top landing-stage of the head gear will run by gravity down to the mill rock-breaker floor, and can be returned on a reverse grade to a lower platform on the poppet legs, which are built specially high to allow of this being done.

The larger mines do their own repairs, and are provided with lathes, punching, shearing, slotting and drilling machines, and woodworking machinery, and the Great Boulder have erected a small iron-foundry of their own.

The next article of this series will deal with milling and cyanide practice at Kalgoorlie.

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* "Mineral Industry," Vol. VI., p. 335.

† I think, as shown by the foregoing data, it is really higher.

TURBINE BUILDING AND TURBO-ELECTRIC STATIONS IN SWITZERLAND.

By Franz Prášil, Professor at the Federal Polytechnic Institute in Zürich.

One of the greatest services electricity has rendered—possibly in the end it will prove the greatest—is that it has made possible the use of long-neglected stores of force. Economy is the great principle of modern material effort—economy in the conservation as well as in the utilisation of the natural resources of the earth. Nowhere, perhaps, is there larger opportunity for its exercise than in making serviceable the world's many water powers. To meet the wide range of conditions they present and enlarge the radius of their usefulness, has required some of the closest study and cleverest work of the hydraulic engineer, the mechanical engineer, and the electrician. Switzerland is pre-eminent in advance in electro-hydraulic practice. By this alone it has held a high position in industrial development in spite of its lack of coal. Professor Prášil is one of the leaders in this branch of engineering, and his review of the progress attained is thus invested with especial value.—THE EDITORS.

NATURE has not endowed the Swiss soil with those treasures that in other lands form the basis on which private and public wealth is built, through industry and trade, and yet Switzerland is a leading industrial country, able, with its products, successfully to maintain its position in the commercial world.

This is made possible because its many water powers atone so plenteously for the lack of coal that very often the saving in power cost is great enough to pay for the transportation of products to the borders of the country, and even as far as the great world-markets, and also because the people, owing to the thorough training in their technical institutions, and their intense practical activity at home and abroad, possess in an eminent degree the capacity for the production of goods of high quality. Machine building takes a leading position among Swiss industries, as is evidenced by the success achieved at the Paris Exposition. In particular, the manufacture of turbines has developed to such a degree, in consequence of the need for making the most of the country's water power, that it is now carried on by twelve companies, whose machines are sold all over the world.

Among these twelve companies, the five following have made turbine building the main branch of their business and devote special sections of their shops and offices to it: Escher Wyss & Co., Zürich; J.

J. Rieter & Co., Winterthur; Theodor Bell & Co., Kriens, near Luzern; Ateliers de Constructions Mécaniques de Vevey, and Piccard, Pictet & Co., Geneva. Among other companies which also manufacture turbines are: The Basel Maschinenbau-Actiengesellschaft; Benninger & Co., Uzwil; M. Bosshard, Zürich, etc.

The diagram, Figure 1, gives a view of the total production of the first five companies, in number and capacity of machines, per year.

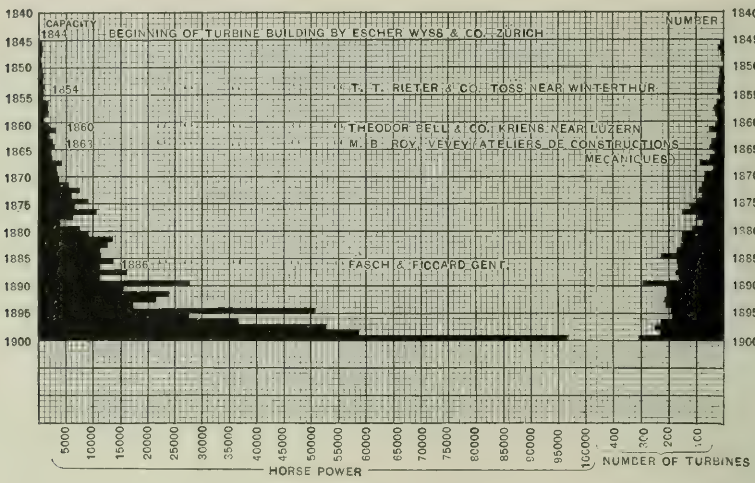

FIG. 1. GRAPHIC REPRESENTATION OF THE ANNUAL OUTPUT OF TURBINES BY THE MOST IMPORTANT SWISS BUILDERS.

I shall have occasion later to return to this, summary statement; at this time I need only remark that the total production of these five companies from 1844 to the end of 1899 was, in round numbers, 5,850 machines, with a total capacity of 638,000 horse power, that the output for 1900 exceeds that for 1899, and that in consequence of the prominence of these companies, their production well illustrates the condition of the manufacture of turbines in Switzerland.

The development of the individual companies and the arrangements of their works cannot here be gone into in detail, but a brief account must suffice.

The firm of Escher Wyss & Co., besides its main establishment in Zürich, has a branch in Ravensburg, Würtemberg, where turbines are also built. In 1894 and 1895 the main works were moved from their old site, opposite the principal railway station in Zürich, to a new location in the so-called Hard, where the manufacture is carried on with the most modern shop appliances.

The *Schweizerische Bauzeitung* for 1895, volume XXVI., page 72 and following, gives a complete, illustrated description of this establishment and its hydro-electric station in Zufikon-Bremgarten. The latter will be spoken of later on in this article, and to this short account of the works proper is added an illustration, Figure 2, which shows the turbine-erecting room in the 110-metre by 100-metre (360 by 330 feet) main shop. It may also be mentioned that Escher Wyss & Co., besides building turbines, make steam engines, boilers, complete outfits for paper factories, refrigerating plants, etc., and also construct aluminum boats and do other ship-building work.

The firm of J. J. Rieter & Co., in close connection with the manufacture of spinning-mill machinery, has engaged extensively in turbine building at its shops in Töss, near Winterthur, which are illustrated on page 55 of the book issued by the Schweizerische Ingenieur und Architekten Verein on the occasion of the thirty-eighth annual meeting in September, 1899. At those works the firm has its own hydraulic-power station, which gives it a field, even though a somewhat narrow one, for testing its turbines.

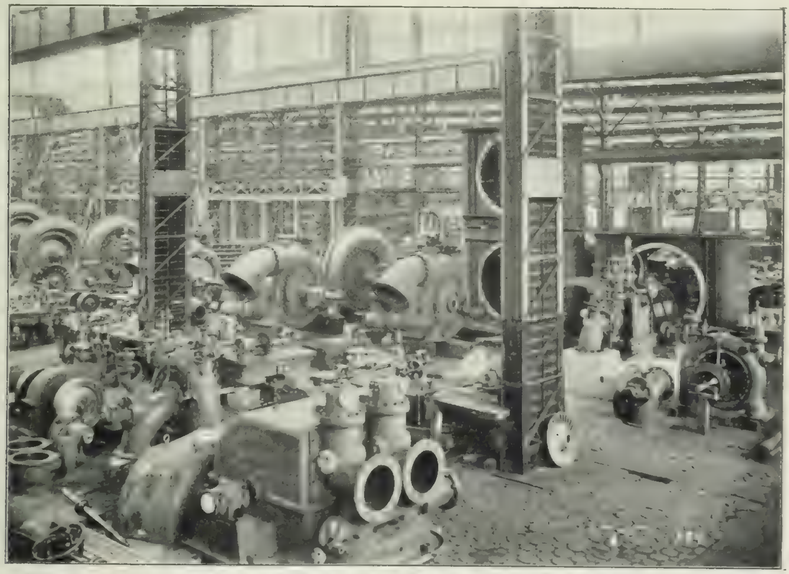

FIG. 2. ERECTING ROOM OF THE TURBINE DEPARTMENT, ESCHER WYSS & CO., ZÜRICH.

The firm of Theodor Bell, at Kriens, near Luzern, which, besides building turbines, does a large business in structural iron, has also modernised its manufacturing methods since its works have been connected with the hydro-electric station which it erected at Rathausen, near Luzern. Figure 3 shows part of the erecting room, with one of the large 1,350-horse-power turbines for the Hagnek Electric Works, on the Lake of Biel, in course of erection.

The machine works founded by M. B. Ray and now bearing the title of Ateliers de Constructions Mécaniques de Vevey, were newly fitted out in 1894 and 1895. The firm of Piccard, Pictet & Co., of Geneva, formerly Faich & Piccard, after carrying on operations for a short time in a small shop, has, within the past year, also moved into a new, entirely modern establishment in "les Charmilles," near Geneva.

The works which have been enumerated, and which employ from 2,500 to 3,000 men in the manufacture of turbines alone, are thus shown to be well-equipped, so that, with their thoroughly trained personnel, they are fully able to meet any demands which may be made upon them.

The qualitative progress can be best studied in the works that have been carried out, in which is evidenced the mental labour of the designing and constructing engineers, as well as the ability of the shops.

It would no longer be of interest to consider the many older plants which, in the course of a comparatively long development, were built for the greatest variety of purposes, as well as for various heads and quantities of water, and in which the water wheels were mechanically coupled to the driving machinery of the factories. Even the power stations with wire-rope transmission at Schaffhausen, Bellegarde, and other places, which, on account of their daring engineering work, were epoch-making, are now of historical interest only.

Moreover, these older plants have been fully treated of in engineering literature, and attention is called to the well-known book, "The Theory and Construction of Turbines and Water-Wheels," by G. Meissner, engineer, published by Costenoble, of Jena, which in its first edition had a rich collection of plans and detail drawings of prominent works.

With the rapid rise of electrical engineering came a higher consideration for water-powers. Figure 1 shows very clearly how, in the second half of the eighties, the production of turbines began to make a striking, though somewhat spasmodic, advance. This was the period in which the first large hydro-electric stations were designed and built, thereby making vital a series of problems whose solution demanded the best efforts of the engineers. Among these problems were the construction of exactly-working automatic governors and an increase in the number of revolutions with even small heads, so that wheels could be directly coupled to generators.

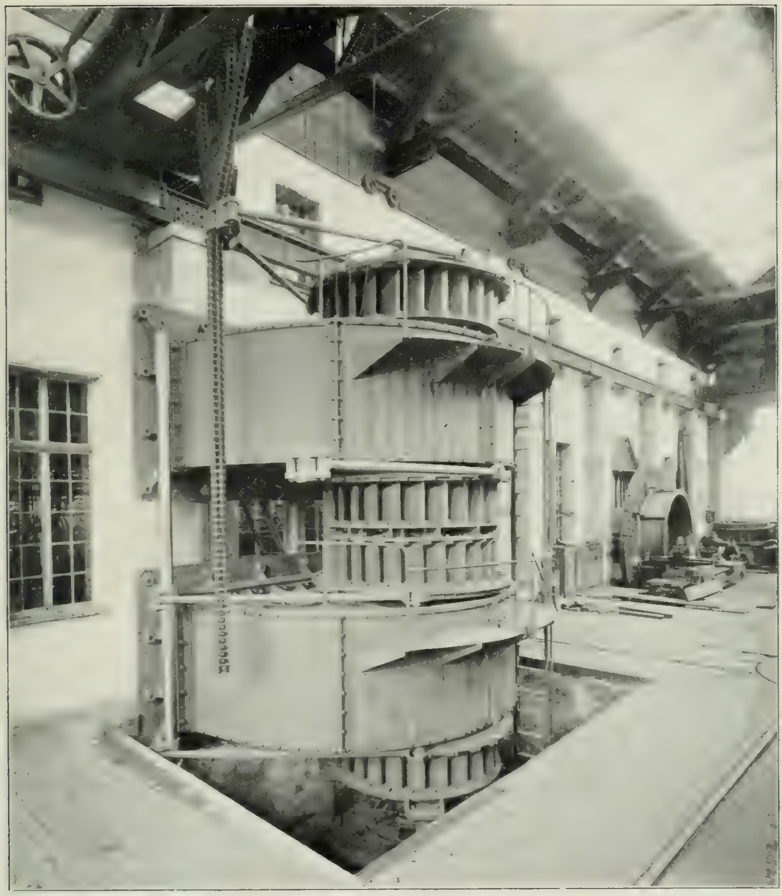

FIG. 3. A 1350-HORSE-POWER TURBINE, DESIGNED FOR THE ELECTRICAL WORKS AT HAGNEK, AS IT APPEARS MOUNTED IN THE SHOPS OF THE THEODOR BELL COMPANY, KRIENS.

It therefore appears proper to follow the progress in turbine construction from this time on, and the year 1889 may be taken as a starting point, for then the first hydro-electric stations with a number of similar units were either contracted for or built.

The large water-works of Coulouvrenière at Geneva, and Letten at Zürich, which were built primarily to supply these cities with water, and in which there were also a good many similarly constructed turbines, were already in operation at this time. These works, it is true, showed a considerable advance in hydraulic engineering, and were of influence on turbine building in so far as they showed the great adaptability of concrete for the construction of turbine chambers of unusually large size. The construction of the turbines themselves, however, shows nothing essentially new, with the exception, perhaps, of the great dimensions of the Geneva wheels. As is well-known, the latter are multiple-ring reaction turbines, with hand regulation, built by Escher Wyss & Co.*

The first large hydro-electric stations, which were built in 1889, were the Schaffhausen central station and the power station of the Neuhausen Aluminum Company.

The Schaffhausen station, which was begun in 1887 as an addition to the power plant of the historic wire-rope transmission, displayed no novelties so far as the arrangement and the construction of the turbines were concerned. Two-ring reaction turbines, some of them built by J. J. Rieter and some by Escher Wyss & Co., drive the horizontal shafts of the generators through bevel gearing. Each turbine is constructed for a capacity of 300 horse power with 4½-metres (15-foot) head.†

The turbines of the Aluminum Company, built by Escher Wyss, which are directly connected to dynamos, have a novel feature designed to lessen the pressure on the bearings of the vertical shaft.

These otherwise normally constructed reaction turbines, each having a capacity of 600 horse power with 20-metres (66-feet) head, are so arranged in their casings that the water flows through them from below upward, and thus causes an upward pressure in the direction of the axis which counterbalances the downward pressure due to the weight of the various parts. Besides this, as the energy required varies rapidly, there is a quick-acting throttle-valve in the siphon-shaped delivery pipe, which satisfies the requirement for prompt regulation.

In 1890, the hydro-electric station at Berne was built.

On account of the considerable variations in head—from 3.5 to 1.85 metres (11.5 to 6 feet)—the three 150-horse-power reaction turbines, from Bell and Co.'s Kriens works, are constructed with three rings, the middle ring having an automatic governor and the other two being regulated by hand. The wheels rest on concrete foundations, in which the channels for the discharged water are cut in a special patented way.

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* The reader is referred to a work entitled "Utilisation des forces motrices du Rhone," published under the direction of the administrative council of Geneva, 1890; Librairie Georg, Geneva.

† An address on this plant, delivered by Dr. Alfred Amsler at the meeting of the Institution of Electrical Engineers in the hall of the Zürich Polytechnikum, on the occasion of the visit of the Institution to Switzerland, is published in the Journal of the Proceedings for 1900, part 143, volume XXIX

In 1891 was begun the installation of the Zürich electric station at Letten, the hydraulic plant of which is remarkable in several respects: The dynamos can be driven by two sets of turbines. One set is fed by the main reservoir of the water-works, while the second set, consisting of high-pressure turbines, obtains its water from an auxiliary reservoir, which is filled by pumps at the water-works whenever there is a surplus of power. The 300-horse-power high-pressure turbines, built by Escher Wyss & Co., have spoon-shaped buckets and are provided with hydraulic governors. We have here, then, a hydraulic accumulator plant, which enables the water power of the Limmat to be scientifically utilised.

This construction of turbines and governors was not, it is true, first made in 1891, but this plant gave an opportunity for a series of experiments in regulation which were of importance for the development of such arrangements of water-wheels.

FIG. 4. RATHAUSEN ELECTRICAL STATION NEAR LUZERN.

The epoch-making results of the power transmission from Lauffen to Frankfort-on-the-Main had the effect in Switzerland, as well as in other countries, of setting free long-latent ideas concerning the utilisation of water-powers on a large scale. Besides the projects already conceived there arose new ones, and so we find that in the years 1892 to 1896 a number of great works were undertaken, each one of which shewed an advance in hydraulic construction.

Beginning with the installations on the Aar, we find that the plant in Interlaken has three units of 180 horse power apiece: Thun has two units, each of 120 horse power, and Olten-Aarburg has six 300-horse-power units. The hydraulic machinery for all of these was furnished by Bell, of Kriens.

The turbines of the first plant are double-ring reaction turbines, with patent aspirators, and are quite similar to those of the Bremen plant; the Schaad automatic governor was used for the first time with them. The construction and operation of this governor were described by me in my report on turbines and their governors at the Geneva Exposition in 1896, published by Ed. Rasher, Zürich.

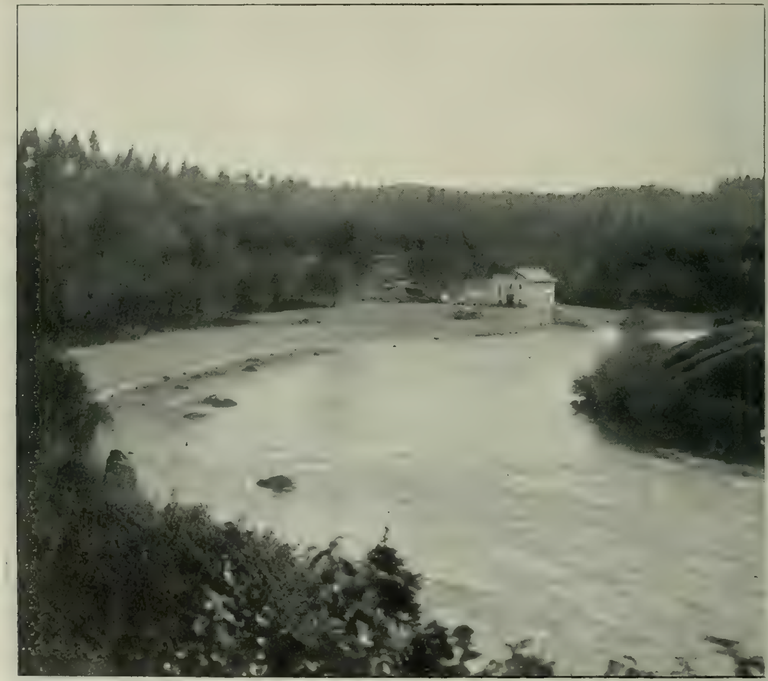

FIG. 5. TURBINE STATION, ZUFIKON-BREMGARTEN ELECTRICAL WORKS.

The turbines in Olten-Aarburg are three-ring reaction turbines of very large dimensions, and are characterised by a very thorough equalisation of the blade-angles in each ring. The employment of a forged shaft, hollow throughout, may also be mentioned.

In these three installations we find already a striving towards, and also progress in the attainment of, the most exact regulation possible, as the use of the above-named governors has led to thoroughly satisfactory results. But it is undeniable that there was found no adequate solution of the difficulties encountered if high speeds were to be used,

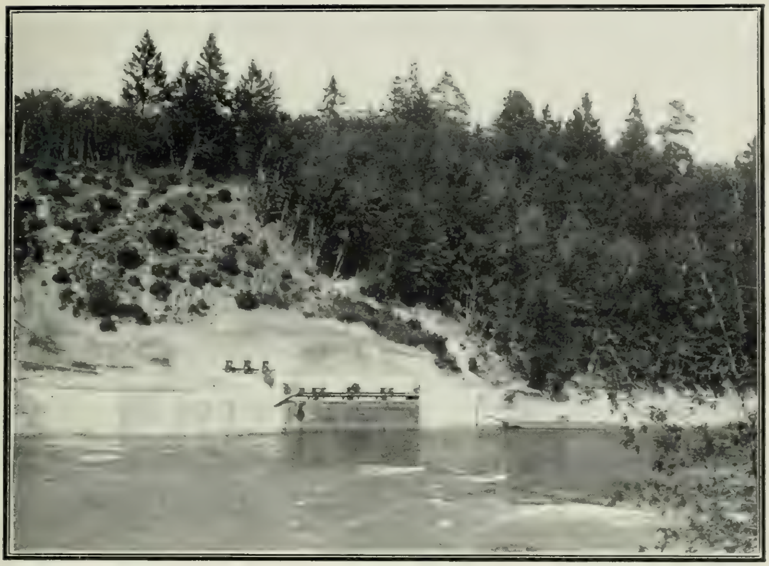

FIG. 6. ENTRANCE TO HEAD RACE TUNNEL, ZUFIKON BREMGARTEN WORKS.

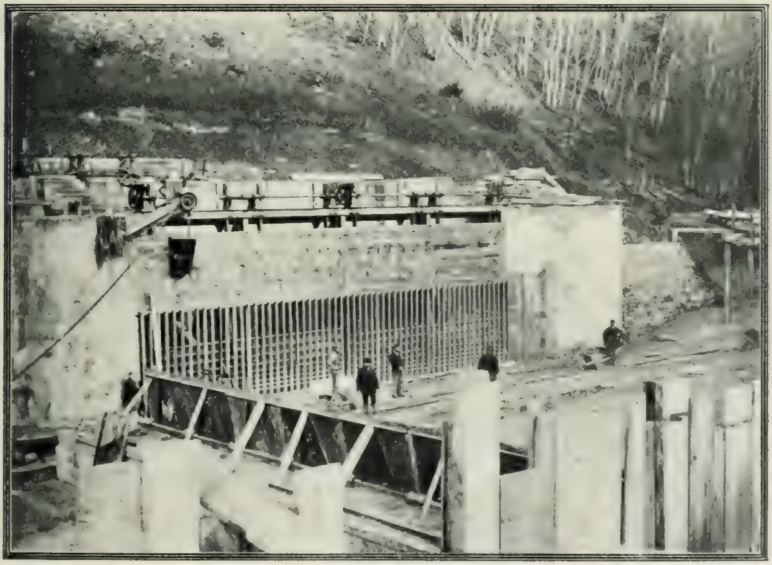

FIG. 7. SLUICE GATE AT ENTRANCE TO HEAD-RACE TUNNEL, ZUFIKON-BREMGARTEN ELECTRO-HYDRAULIC INSTALLATION.

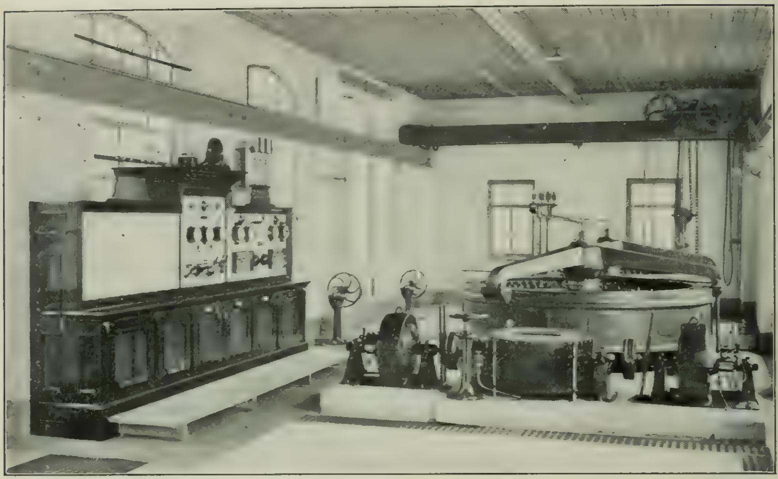

FIG. 8. ZUFIKON-BREMGARTEN WORKS. MACHINERY ROOM.

although this would have been desirable on account of the comparatively small and very variable heads which are characteristic of the conditions at all three plants.

Other installations on the Aar are those of the Wynau electric station, with five 750-horse-power units and two 120-horse-power units; of the town of Aarau, with two 400-horse-power units and one 200-horse-power unit, and of the town of Brugg, with two 150-horse-power units. All these turbines, with their attachments, were supplied by J. J. Rieter & Co., of Winterthur.

During the period from 1892 to 1896, the electric stations at Rathausen, near Luzern, and in Zufikon-Bremgarten were erected on the Reuss.

The hydraulic machinery of the Rathausen installation is a culmination of the type of low-pressure plant that has hitherto been manufactured by the Bell Company; a careful working out of all the mechanical details, as well as a convenient and easily accessible arrangement of all the parts make this plant a model one.

With a head varying from 4.12 to 4.82 metres (13.5 to 15.8 feet), this station has a capacity of from 1,200 to 1,500 horse power, which is converted into electric energy by means of direct-coupled two-phase generators with a voltage of 3,300, and thus supplies Luzern and the vicinity with power and light. Figure 4 on page 251 gives an outside view of the station.

The plant in Zufikon-Bremgarten, already mentioned, is of high interest because it shows a decisive attempt to increase the number of revolutions.

The plant is shown in Figures 5 to 8; it is near the little town of Bremgarten, in the Canton of Aargau, where the Reuss makes a bend of nearly 180 degrees. By building a dam 70 metres (230 feet) long at this point, a head of from 5 to 6.5 metres (16.4 to 21.3 feet), gross, was secured, and the water is led through a tunnel 350 metres (1,150 feet) long, the maximum flow being 25 cubic metres (883 cubic feet) per second, directly to the turbine house.

In order to secure a higher speed, the turbines, built by Escher Wyss & Co., are double ones in concrete casings. There are four units, each of 325 horse power at 115 revolutions per minute, and each directly coupled to a 5,000-volt polyphase generator. Of the available energy, 400 horse power is transmitted to the works of Escher Wyss & Co. and 200 horse power to the flour mill of Messrs. Maggi & Co., a distance of 20 kilometres (12.4 miles), by means of two three-wire lines. The remaining energy is delivered elsewhere. Work is in progress for the purpose of getting an increased head of water, and in connection therewith new forms of turbines will be used. The completion of the original part of this plant occurred at the same time with the closing of contracts for the installation of the two largest hydro-electric stations of the Continent, those of Chèvres, near Geneva, and of Rheinfelden To the description of these important stations my second and concluding paper will be devoted.

THE UNKNOWN MINERAL DEPOSITS OF THE PHILIPPINES.

By Frank L. Strong.

The truest service which can be rendered to industry and capital is sometimes to warn them against over-assurance. To know that the received information on a subject is misinformation—to know that there is no exact information—is the beginning of real knowledge. It is in this spirit that Mr. Strong writes, with the preliminary explanation that the review of the mineral resources of the Philippines at this time can scarcely be more than "a large I don't know."—THE EDITORS.

ALASKA possibly excepted, no transfer on a large scale has ever been made in modern times of land about which so little is known by either the old or the new owner as in the case of the Philippine Islands.

Spain, indeed, left many records, geological, climatical, agricultural, mining, etc., many of which were made with the appearance of elaborate painstaking as to facts. But Spanish policy frowned upon manufacturing, and no incentive was offered to develop what the records said existed.

These records present many a rosy picture to the new arrival. Clear, explicit, frequently accompanied by elaborate drawings, he feels he has but to follow to success a track made clear by his predecessors. A few months, and the illusion is dispelled; he has learned to distrust all information derived from Spanish sources.

It is not asserted that these records were made to deceive. Not at all. Terse, clear-cut statements of fact, arrived at after painstaking, scientific research, are a modern innovation upon the easy-going guesses and traditions of the past. But few nations have reached the point even yet, Spain being one of the laggards.

To illustrate the Spaniard's lack of accuracy may be cited the case of the Manila & Dagupan railroad, some 120 miles long, the only railroad on the Islands. The Spanish Government had the line surveyed by its own engineers. Elaborate charts were prepared, showing all details—route, grades, fillings, borings for bridge foundations, etc. English capital became interested, a rigid contract was entered into, and the work was begun. It was discovered in many cases that the engineers reporting the survey had never been upon the ground—that the road as laid out was impracticable. Marshes and quicksands were found where the drawings indicated solid ground, and dense jungles existed on the route where the foot of man had never trod. Even rivers were there of whose existence the engineers were ignorant.

The English company was obliged to expend largely in excess of the estimated amount, and had to face many grave engineering problems the Spanish engineers had not dreamed of while surveying the route from their comfortable office in Manila.

To attempt in a brief paper to speak even in general of all the resources of the Philippines would be futile. Unexplored as they are, as a whole, by competent observers, the Islands from all that can be gathered are extremely fertile in soil and rich in timber, minerals, and all else requisite for great manufacturing industries. Easily controlled water power is found in numerous places. In this paper I will briefly touch on mining features only.

Gold naturally is of primary popular interest. During the year of the Spanish-American war I met many members of the Colorado Volunteers, who came here intending to remain after their terms of service expired, and search for gold. They were expert miners and many did remain. Hundreds of others have come from the States and elsewhere on the same errand. While the insurrection greatly limits their field of search, our local newspapers teem with their wonderful discoveries. I meet many personally, am shown small vials of virgin ore, specimens of quartz of great richness, and hear the old, old stories so familiar in the States. From the friars, who have lived for years in the interior; from old residents, who know it all; from Spanish Government records and other sources—I am surfeited with gold talk.

Possibly I am over conservative, but I have seen and heard of nothing yet to make my pulse beat one stroke faster. Gold can easily be obtained from the natives. One of the mines most famous in past years is found to yield an industrious native about five cents' worth a day. As he cannot eat or smoke it, it accumulates on his hands, until by several months' labor he gets an amount which will fill a tiny bottle half full. This is the gold my prospecting friend buys and exhibits as his "find." There are many such celebrated mines in Spanish records.

In dismissing this subject I do not say gold may not be found here in paying quantities. Much is found in Japan, where geological conditions are probably similar to those here. The insurrection prevents extended search. Spanish lethargy may have passed unnoticed what to an American would prove a bonanza. The new processes of the day may utilize ore which is beyond the reach of the crude methods of the native. All one can say to-day is that we know practically no more than before the United States took the islands.

Land titles are yet to be decided, and the numberless claims now being staked out may not be worth the value of the stakes to the man who drives them, even if the metal is found in the future. A miner's exchange has recently been organized in Manila, commencing with one hundred and twenty *bona fide* miners of those directly interested. This will tend to place matters in a business form, and the mining legislation expected in the near future will establish a basis to work on.

The world will doubtless soon know if the Spaniard, whose scent for gold in past centuries was keener than that of any other nation, has slumbered for three hundred years on his own El Dorado. If its undiscovered richness has fallen into the hands of his conquerors, this would indeed add to his overflowing cup of bitterness.

Coal:—To the prospective investor a subject far more important than gold is presented. Coal is king. For the scores of steamships of the present, and the hundreds of the future; for the railroads projected and certain to be built; for the coming manufacturing industries—coal is imperative.

I have gathered statistics from many sources—Spanish records, both public and private have been at my disposal—and I am in close touch with those owning mines, whether opened or prospective.

There have never been found in these islands to date anything but lignites. Of these, large deposits exist, widely distributed among the various islands. Some are easily accessible to the sea. One of the largest and most important worked would require an expenditure of $100,000 to put in a railroad and other essentials for handling the product. About fifteen tons per day is its present output.

Philippine coal much resembles that of Japan, none being equal to that of Australia, so largely sold here.

That I have thus far examined includes samples from some of the best-known mines, giving an analysis about the same as that of the average Japanese coal. However, as Japan contains one mine so superior to others that the government there controls its entire output for naval vessels, so we here may at any time find grades of superior excellence. I had strong hopes of being able to analyze samples from a mine located near the coast of southern Luzon. It is said all small Spanish gunboats that could enter the port formerly coaled there, and its quality was above the average. You will understand difficulties of obtaining reliable data at first hand from the fact that a friend interested in the mine, who was to send me samples for analysis, was murdered by natives while examining the property. His two white companions were also boloed.

As Australian coal sells in this market at $10 a ton gold, and not a strong coal at that, and Japanese coal at $9, the incentive to open up mines is very great, and we shall look for much activity in that line as soon as the insurrection closes.

Copper:—The islands have large deposits of very rich copper ore. Before the insurrection the local market was wholly supplied from mines to the northward of Manila. I know of great quantities of ore, at present too far from the market to admit of mining at a profit. Facilities which will be provided later will put it on board cars. Smaller but very rich mines can be worked to good advantage now.

Iron:—The iron ore of the islands is said by reliable authorities to be of superior quality. Futile attempts to mine and prepare it for the market have been made in recent years, but impediments thrown in the way by the Spanish authorities resulted in their abandonment. These deposits are said to be very large, are easily accessible, and with the known excellence of quality are simply awaiting the time when conditions warrant the necessary expenditure of capital to utilize them.

Other Ores:—Manila contains two excellent museums, in which are exhibited all articles of interest from the islands. In these are seen samples of almost every known ore. That large deposits exist of all the useful ores, is the evidence of all whom I have met, whose long residence and facilities for observation entitle their opinion to weight.

The knowledge of the resources of these islands I obtained while an engineer in the Navy during the Spanish-American war has been greatly increased. The facts upon my first visit, obtained from some thousands of miles cruising among the islands, and from interviews with those in position to know, led me to return. My added knowledge has decided me to remain after my duties as consulting engineer for the construction of the half-million-dollar refrigerating and ice-making plant shall have ceased.

Too much stress cannot be laid upon the wisdom of American manufacturers of machinery securing an early representation in this field. The machinery selected for the government plant just mentioned, and many thousands of dollars' worth placed elsewhere, have proved a revelation to users here. English machinery has had entire control, but American manufacturers have but to bestir themselves and adopt the same methods of selling as the English, to secure the trade.

THE STEAM MOTOR TRUCK AS A PORTABLE POWER HOUSE.

By James Grieve Dudley.

The motor truck seems destined in the very near future to affect materially the economy of the distribution of goods. Its more immediate interest to a mechanical constituency, however, is its rapidly rising importance as the basis of a new mechanical industry of production. Hence the importance of all study or discussion tending to fix the principles or standardise the practice of its construction.—The Editors.

DEMANDS for motor vehicles have now assumed such proportions and permanence that the engineering world is fully warranted in asking whether we may not evolve from all this agitation over what is now the rich man's plaything—the modern machine for racing or pleasure—a motor truck which may successfully supersede horse traction of heavy loads, on a basis both sound commercially and practicable mechanically. Such an achievement would open up, I think, additional fields for its adoption, since success under unfavorable road conditions would render doubly possible its success under the fixed and favorable conditions of rails, at least.

So broad is the subject that this discussion will be confined to an analysis of the fittest substitute for the hauling of heavy loads by known and tried motive powers at the present day over city streets and country roads, as they are now to be found in the United States only.

The fittest motor truck must, first of all, meet every requirement of existing horse-drawn trucks; second, its initial cost must be within the means of the buyer; third, its operative cost must represent a better investment than the care and keep of the horse. The second condition can be demonstrated only in the open market, but the third assumption I shall assume to be admitted as possible, certainly when, for instance, a design shall be evolved which shall fulfill the specifications laid down herein.

Elimination of horse traction, or rather the substitution of mechanical propulsion, instantly sets us certain definite limitations and gives us a wholly new point of view of the hauling of goods, as for instance in the adding to the truck itself of the weight of the motor parts with their accessories, in order to *drive* such loads as were formerly *hauled.*

Every pound thus added to that of the existing truck should be so applied as to bring the centre of gravity of the whole as low as possible, and further should be so distributed that the tractive force on the face of the drivers should be in proportion to the live load carried. Under no conditions should the dead load be less than that of the horse displaced; a position which disposes of the revival of the early though fallacious attempts to solve the problem with so called "tractors."

A comparative analysis of the fittest known and tried motive powers for this given service is beyond the scope of this inquiry, and will not be here attempted; yet in support of the premises hereafter assumed it is necessary at least to predicate the standards and limiting conditions under which such an analysis has been conducted and my resultant conclusions have been reached.

Primarily then, our hypothetical motor must possess that *sina qua non* of every machine which is to be handled by persons not only untrained but often grossly ignorant, namely, safety.

To meet the requirements of the average American our machine must be well-nigh automatic in its simplicity of operation, for a nation of indefatigable inventors are satisfied with little which calls for that skill and attention in the handling of machinery which others are able and willing to spend in reaching given results.

Durability should, for like reasons, stand well to the fore if the motor truck is ever widely to supplant or largely to supplement horse traction.

To compete successfully with the horse, the motor truck must possess that same reliability upon which, for example, the farmer depends in daily delivering his horse-drawn load of produce to the city markets.

Since we can set no limitations to the character of locality or goods-service which shall determine the adoption of horseless trucks, it follows that the fittest must be absolutely independent of any fixed base of supplies, or repairs, or source of operative skill; for, if successful upon the sandy roads of Florida, it will be wanted, and should be equally successful, upon the rocky roads of the mountains of the far northwest. As a matter of fact it is a fair presumption that the evolution of a motor truck fittest for the severely adverse American conditions is likely to develop a type which will recommend itself for well-nigh universal adoption.

The ever varying conditions of the weight and character of loads hauled, of roads, of grades and weather, call for unusual flexibility in the delivery and manipulation of the selected power, whatever that may be.

Economy of operation must be the final determining factor as to which motive power is most fit, but not until the competitors for this honor have tied on all other scores.

Comparing then, the known and tried motive powers with these standards—safety, simplicity, durability, reliability, independence, flexibility, and economy of operation—it appears that, as the fittest for the motor truck which shall have wide adoption, steam should be the motive power selected. Assuming steam to be adopted for our proposed truck, there naturally arise most of the questions discussed and many of those disputed in the engineering world every day in stationary, locomotive, and marine practice. It is well, I think, to start out with the axiom that "What is wrong on fixed foundations is doubly wrong on moving ones." Yet on the other hand, it hardly follows that "The best in stationary practice is necessarily the fittest for motor-vehicle work." Where, however, it is commercially feasible and mechanically and practically possible to employ the refinements of advanced engineering, then the corollary of our axiom certainly should be carried out in our designs.

With these axioms, corollaries, definitions, and conditions before us, let us see what we may fairly demand in our specifications for a steam motor truck, which shall most nearly meet the stipulated desiderata. Starting with the necessary fuel, it should be: ashless, smokeless, condensed, of high calorific value, absolutely safe, cheap, and universally obtainable. Kerosene and fuel oil alone meet these conditions.

The burner therefore should be noiseless, non-clogging, non-carbonizing, automatic, safe, and simple. A search of the market or the patent office will disclose multifarious means devised to accomplish these results, though the process of evolution does not seem to have yet brought forth the fittest.

We next advance to the boiler. Could we settle this point for motor-vehicle service, we would unquestionably settle it for well-nigh every service; hence I shall simply lay down certain dicta and stand on guard to meet attack. The given service is such that one prime requisite of all boilers must here take precedence of everything else, namely, absolute safety. But one type of boiler wholly meets this condition, if we may except the so-called flash boiler, and that type is the water-tube. For motor-vehicle work, there must be added one other desideratum at least, namely, that it shall be self-contained. Intimately associated with boiler design arises a point too often disregarded, certainly in stationary practice, and that is securing the maximum of heat insulation; for, why seek high furnace temperatures, rapid steaming, superheated steam and feed-water, if radiation (intensified by the very character of the work to be performed) goes on unchecked or poorly prevented? A problem by no means easy of solution is that of the boiler feeding, since, in the whole field of steam engineering, we can scarce find a parallel to the fluctuations of grade, steam-demand, load, etc. The natural attempt at a solution of this problem is to employ the pump in some form or other, but it requires no great expenditure of thought to conceive situations where means more automatic and flexible must ultimately be devised if we are to master the steam-motor-truck problem. As a *sina qua non* in our portable power house, there should be a feed-water heater of high efficiency, the particular form of which may be made to suit the fancy of the individual designer or the special needs of the truck in hand, so long as the maximum results are attained in pre-heating the boiler supply. There are many points of similarity in the functions of boiler and heater, hence many of the essentials in the construction of the former have equal weight in devising the latter.

The *crux* of the whole steam-motor-vehicle question might be summed up in water purification. Under no other service is the steam boiler subjected to conditions so severe as when compelled to "travel upon its belly through an enemy's country." It is evident that I am assuming here, as I have above and shall below, that we "in the States" are hardly yet ready to "run condensing." Since we throw away our exhaust, we must subsist on anything and everything obtainable in a liquid form which passes under the name of water. There are, of course, many solutions of the problem of purification, but none can be made to cover all cases; hence we must carefully investigate each and every one and adopt such means and methods as are best suited to the individual conditions. One method we must not even take into consideration, and that is the use of boiler compounds. Every steam-motor-truck designer should raise his voice against even initiating this practice, and thus safeguard an art of fast growing responsibility and proportion. First of all, boilers of whatever size, type or design should be so constructed as to make every possible provision against the harmful effects of bad water, if used, and, by insuring continuous, rapid, and free circulation, prevent the lodgment at any time of impurities at any point in the system, save in some entrapping drum specifically provided therefor. Next, if possible, boilers should be fed only water which is known to be free from organic or inorganic matter in suspension or solution, such, for instance, as rain water, some few natural spring waters and, of course, waters which have been distilled. In this last means we touch upon one practically universal specific. However, it may not always be feasible either to set up or to operate a still of sufficient size or to depend upon it after installation, yet individuals or corporations owning several such vehicles certainly should supply their stations with pure water secured by distillation or chemical treatment, but under no circumstances should the chemicals be injected into the internal economy of the boiler. Granting that bad water is to be used, even occasionally, there are two precautions to be observed with the greatest fidelity, namely, to employ the best obtainable filtration of the water supplied, and to blow-down religiously after every run until the heater and mud-drum are cleared of all harmful contents.

Steam pressure, in motor-truck practice, should unquestionably be high—say 250 pounds, with high superheating, which latter can and properly should be accomplished by the design of the boiler; if not, then some form of separator in addition is certainly demanded.

As to the engine, one hesitates to lay down dicta additional to those above recited; still, simplicity and durability at least may be insisted upon. Twin or multiple-cylinder horizontal high-speed engines seem to be "indicated," as the physician would say, for sound designs; but beyond this it is not well to go, save to suggest that in the larger trucks a pair of such twin or multiple-cylinder engines, rather than a single such engine of equivalent power, would provide for many an unforeseen contingency which must inevitably occur in practical operation.

When it comes to valves and valve-gears, the cry should again be for simplicity and durability. Just here, I think the enormous demand for improvement in the steam engine may bring forth the unknown genius who may devise a movement and a means which shall give us a steam consumption in these diminutive motors comparable with that recorded by their larger counterparts; but one may be excused for maintaining an attitude of optimistic skepticism on this score. More will undoubtedly be accomplished in that direction by improvement in boilers and burners, which will enable still higher pressures to be attained than our assumed 250 pounds to the square inch.

In so disposing of the exhaust from our simple engine as to avoid annoyance to the public, we are forced to employ some form of muffler, and further to make such disposition of the vapor as shall render it invisible even in winter weather. Amongst the many possible solutions of this feature of the problem the ingenious designer should find one or more means which will utilize some, at least, of the latent energy which, in the usual practice of wasting to the atmosphere, serves to account for the low efficiency of the steam system when compared with its theoretical possibilities.

Of lubrication, it is unnecessary to say more than that it should be liberal and automatic, for not otherwise will we render "fool-proof" designs which may otherwise be of superlative excellence.

Fittings should be beyond criticism in material, workmanship, and design, and none used where by the exercise of skill, experience, or ingenuity, it might be dispensed with. First cost should be no bar to the best. These conditions apply with equal force to all boiler, engine, or other trimmings and tools, for whatever purpose employed about the truck.

Locality, the personal equation, and the kind of goods hauled, must largely influence water and fuel-storage. It is, however, advisable to provide an excess of the latter over the former, based on the assumed average steaming radius, which might even be set as high as a ten-hours' run without placing too burdensome a dead load upon our mechanical horse. The supplying of both of these liquids (respectively to the boiler and the burner) should unquestionably be entirely automatic after starting, and the designer should be on his mettle until he has succeeded on these lines.

Air-storage and its after utilization for many purposes, such as operating all automatic devices, cleaning, starting, braking, steering, signaling, etc., constitutes a most satisfactory auxiliary in a motor vehicle, but it is by no means indispensable. The best method of obtaining such air-supply is a fertile field for the inventive mind and no doubt many excellent means have been, and will be, brought out.

Having now analyzed the means for generating our power, we pass naturally to the second phase of the problem, namely, the application of that power to the driving, steering, and braking of the truck under service conditions.

It is clearly evident upon a moment's reflection that the haulage of goods over our present streets and roads calls for only the most moderate speeds, save in exceptional cases, delivery wagons, so-called, being considered outside the scope of our inquiry. If we can do successfully by steam that which is now done by the draught animal we shall achieve a great forward step, which will increase in proportion as we excel the horse; but it is well to bear in mind that we have no mean task in even equalling the horse, all things considered. The draught animal does his six to ten miles in the hour, though scarcely for a stretch of ten continuous hours, but we may count on the motor truck doing this and more with no evidence of fatigue. So it is clear that we may design the driving gear *without speed changes,* and safely calculate upon excelling the draught animal if our normal speed is, say, eight miles per hour. Having determined our driving speed, it is a short step to the power-transmission device, which again may be bounded by simplicity and durability, and should involve the minimum of friction and lost motion even under neglect and adverse conditions. The chain and sprocket must, I think, be rejected for this given service. Following our own criterion of simplicity, we should control the starting, stopping, backing, and possibly the braking, with one mechanical member which should be absolutely under the driver's control, and only operative with him in the cab.

In such heavy work as we are considering, the steering should certainly be done by power, or in any event should be self locking and call for no muscular effort from the driver. It will be noticed that if the many problems enumerated above are successfully solved by the designer, then, when our steam horse is ready for his day's run, one man only will be needed on the box—the same sober, intelligent, able-bodied, clear-eyed, prompt-acting driver who may have been in the owner's employ all his lifetime.

The absence of automatic features must inevitably necessitate the employment of an assistant, which cost can fairly be charged to the motor truck and credited to the horse since he requires but a single driver. It is almost superfluous to specify that vibration must be eliminated from the steering device, yet this seems not to have been done in numbers of pleasure vehicles now on the market.

There remains now but one operative feature to discuss, and that is braking. Here again, power of some sort should be employed, to render this the more certain when recourse is had to it, seldom though it be. An emergency foot brake in addition should also be figured in.

A word or two in the way of suggestion on signals may not be amiss, since we are aiming at present perfection. With an abundance of compressed air and steam at hand, there need be no difficulty in issuing warning notes; but it is surprising that designers have apparently overlooked or disregarded the fact that musical notes carry farther and are more readily heard than unmusical ones. A whistle or equivalent device of pleasing as well as penetrating note should be adopted. As to optical signals, the use of the daylight-white acetylene leaves little to be desired and it should certainly recommend itself to all builders.

The design of the truck itself logically divides itself into wheels, tires, body, and springs, but they are best treated individually by treating them collectively. The horseless motor truck is unquestionably a more complex problem than even the locomotive, for the former has few, if any, of the fixed conditions under which the latter operates; it therefore behooves the designer of the truck to enter upon his problem with humbleness of spirit, not assuming omniscience in this branch of engineering unless he be prepared to defend his claims. In short, the fittest motor truck is likely to be the achievement of several associated designers, each expert in the particular art treated, and since the dray of to-day is so satisfactory an evolution of many minds working through many decades, I think we will do well to stick very closely to that. The dished wheel, for example, has proven itself the staunchest known form, certainly for American roads, and it is the dished wheel which compels the use of the bent axle whence results the unavoidable "undergather." This undergather necessitates, perforce, the rotation of the wheels upon rigid axles and prohibits the revolution of fixed wheels upon revolvable axles. In such trucks it has even been found that a certain amount of foregather between the forward halves of the wheels is necessary to secure the best results, thereby again complicating the problem of trying to revolutionize a machine already most fit. Like contentions hold true as to the springs and form of body or platform best adapted to carry a given kind of goods. For reasons such as these, it would seem to be the better part of wisdom to adopt the horse-truck as we find it to-day, to absorb it, and to adapt our motive power to this fretful porcupine rather than to attempt its reconstruction and be pricked for our pains.

In just one particular only do I think marked gains can be made, and that is in the tires. Unquestionably we should exhaust all our skill, study, and ingenuity in perfecting a tire, for the drivers at least, which shall exceed in durability and tractive power anything now in use. When we consider that the adhesion contact of the wheels varies from mud, or ice-lubricated asphalt grades, through hock-deep clogging clay, up to level stretches of gritty faced macadam—the road *par excellence* for heavy hauling—we understand both how difficult is the problem and how great the gain in the event of success. If, combined with a face of increased adhesive power we could at the same time secure such resiliency as would relieve the truck-body and machinery from shock, we should very nearly approach the ideal. In France, I understand, rope-wound wheels are now in use—a most ingenious and effective tire, but one which would never succeed upon American roads owing to the rapid cutting and rotting of the fibres to which they would be subjected.

And now to sum up:—The logic of shrewd business and sound engineering seems to declare in no uncertain language that the fittest motor substitute for our present two-horse trucks, when employed in hauling goods over our present streets and roads by means of some known and tried power, must be: operated by steam generated by kerosene fuel under self-contained water-tube boilers, the boilers being automatically fed with water freed from chemical and mechanical impurities, and preheated to as high a degree as in any other branch of steam engineering; that no means or methods rejected in other fields of steam use shall be tolerated; that every refinement of the most advanced steam practice shall be employed when this is commercially and mechanically feasible; that we must seek perfection by the design of each element of our portable power plant by experts skilled in that particular means or method; that the horse-drawn truck of to-day has so assuredly proven its commercial and mechanical fitness that it must be adopted practically *in toto,* and our motive power in consequence must be adapted thereto; and, finally, that it shall be safe beyond peradventure—so simple as to be readily handled by the present driver, newly-enlightened—so durable as to represent a far better financial investment than when horse-drawn; thoroughly reliable in all weathers and seasons, on all roads and accustomed grades, with any contemplated load or no load; absolutely independent of any fixed base of supplies; flexible to manipulation in starting, stopping, steering, and backing; and lastly, so economical in fuel costs and in repairs as to be well within the reach of even the Yankee farmer.

EDITORIAL COMMENT

The true meaning of the steel situation is easily foremost in international importance. Active as was the stir made by the sudden entry of American locomotives, American bridges, American rails and ship-plates, into foreign and even into British markets, it was quietude compared with the reception given the announcement of the formation of the great American "Steel Trust." This is looked upon by some as a menace to the iron and steel makers of Europe, so close and so deadly that Britain should throw to the winds the fiscal and commercial policies under which she has prospered ever since her manufactures were founded, and try some artificial dosing from the protective-tariff bottle. Meantime, in the land of its birth, consumers shake their heads gloomily and look with apprehension to their own destruction through the giant greed of this new monster, which may dole out the necessaries of industrial life from its hoard only on such exorbitant terms that profits will be wiped out, prosperity will be strangled and progress stopped, Truly, a most pernicious organisation, destroying its own customers and markets at home in order to "dump down" its products at less than cost abroad!

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It is rather curious to notice that the interest and excitement have been confined almost entirely to industrial circles; the financial world has viewed the movement with almost unmoved placidity. The promotors toss hundreds of millions of dollars from hand to hand: concerns whose individual capital would have staggered the financier of a quarter century ago are bagatelles in this stupendous game; finally the rustling securities are deftly gathered into one grasp—fourteen hundred million dollars of them—and Wall Street is scarcely flurried; general credits are undisturbed; the markets are relatively unexcited, and rates on money are unchanged. And yet the whole combination is exclusively a financial deal. It does not involve the creation of any new industrial undertakings, nor, in all probability, the elimination of any old ones. Indeed, it is not assuming much risk to venture the assertion that few industrial consolidations have involved less physical change than seems likely to attend the consummation of the present one. There was already a remarkably good understanding between the independent concerns which are now components of the giant consolidation. There was an exceptional harmony of co-operation along the whole line, from the ore miners to the contractors for finished steel structures. The combine has not thrust forward any Napoleon of manufactures—indeed, so far it has been characterised by a negative influence only on industrial leadership—the apparent retirement from activity of Andrew Carnegie, the most commanding figure of modern times in the practical advancement of iron and steel making. His most trusted lieutenants remain, but essentially the movement means the passing of the dominance of the manufacturer and the ascension of the throne by the financier. It means the subordination of the effort to surpass by competition, to the effort to dominate by regulation. And, as our esteemed contemporary, the New York *Journal of Commerce*, says in one of the ablest reviews of the subject which has come under our notice:

> "The world has not seen progress and success achieved without competition. It is not prepared to say that this cannot be done, but it is excusable for regarding experiments in that direction with skepticism. * * * Mr. Carnegie's busi-

> ness sagacity has done more than anything else since Bessemer's invention to cheapen steel, expand the market for it, and create the present enormous profits of the business. Mr. Carnegie has been a competitor from the beginning and he has been strictly and exclusively a manufacturer and not a financier. He has generally kept out of combinations to reduce competition; he broke the steel-beam pool and the steel-rail pool which sought to restrict production and keep prices up, and from the beginning his policy has been to control everything from the ore bed and the freight car up to the finished product. The present combination has been created to reverse Mr. Carnegie's policy."

What direction the "regulation" will take will be a study of intense interest. If it be in the direction of adjusting output to demand, and avoiding the alternating conditions of over supply and under production whose baneful effects Mr. Hull discussed lately in these pages, it will be, so far, widely beneficial. That it can go much farther is not clearly apparent. If the Trust is to do a full volume of business, there cannot be an extensive abandonment of existing plants. Readjustment and condensation of organisation has the marked attendant disadvantage of setting free much of the individual talent and enterprise which built up the present industry—and it must not be forgotten that the United States Steel Corporation, huge as it is, by no means monopolises the business of the country. There is many a giant killer yet at large and unafraid.

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And after all, are any economies of administration likely to offset the extravagances of capitalisation by which the plans so far have been characterised? As for operation, there seems to be no room for doing away with intermediate or "middle-man's" profits. Every profit now paid by the iron, from the time it is taken out of the ground till it is left in the finished bridge, is retained and augmented, in the form of dividends on the proportionate representation of the new stock. The steel product must pay all it ever did, to builder, steel maker, blast-furnace man, ore-carrier, miner—apparently must pay more than it ever did. Where is the economy of production to come from—where the advantage to the consumer or the menace to the outside steel maker? The colossal combination may bring forward what the *Journal of Commerce* terms an "industrial Cromwell," capable of making the "other members exert themselves as competition made them in the outside world." The struggle to satisfy shareholders, expectant of dividends even in adverse times, may supplement the still existent competition from without and prove powerful enough to keep the industry advancing toward greater and greater economy in manufacturing, of which economy the world at large will be given a considerable share. It has been so with the Standard Oil Company, in spite of lack of competition. But it looks very much as if the American steel trade had turned away from its old leading principles, and further had practically put upon itself a burden of fixed tonnage charges, as hampering in external competition as those which Mr. Phillips, elsewhere in this number, lists against the British steel maker. The profits per ton of finished product which the new corporation must earn, to pay interest on its bonds and dividends on its shares, work out to an alarming figure.

The names of the financial sponsors of the enterprise make skepticism appear the height of audacity; nevertheless it is very hard to hold a firm faith that the earnings will be sufficient when the present times of prosperity yield to the industrial depressions which heretofore have periodically affected both Europe and America. And already clouds are rising over Germany.

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The power of so stupendous an aggregation of capital is impressive—and it is stupendous even assuming, as asserted, that the total actual values of the properties amalgamated would approximately equal the bonded indebtedness only. The possible strength of a unified and centralised control of all the elements of steel making, from the ore and coal in the ground to the finished product or structure, is also enormous. But it is not apparent that the change from former conditions should infect with panic either consumers in America or producers in Europe. The former may be reasonably sure of a commercial policy as enlightened as that heretofore characterising the dealings of the steel producers, and of greater stability. It is a pretty safe guess that the Trust will endeavour to stimulate consumption and to promote the prosperity and hence the buying power of the consumer—not to narrow its markets by an inordinate advance in prices. The British iron and steel trade will see more clearly the competition they have to meet, but it is not quite apparent that they will be in any worse position to meet it. Their dangers will be, as they have been heretofore (Mr. Phillips sums them up most succinctly in this number, page 173 to 186,) the greater advantages possessed by the United States in respect of natural resources and in respect of the general adoption of labour-saving appliances and of methods ensuring the utmost of economy.

The former, perhaps, constitutes a permanent difference. The latter certainly does not. Every economical appliance and advanced method at mine, docks, blast furnace, steel works, and mill can be adopted by British masters. There may be deplorable opposition by labour to overcome, but overcome it will be—as it always has been under analagous conditions. And here Britain has an enormous margin of potential economy which she may make actual. Her possibilities in this direction are vastly greater than those open to America, for she has these yet unseized opportunities still available, and after that an ability to push forward along advanced lines if only she is keen to recognise and adopt the most advantageous modern methods. If, while handicapped by antiquated and wasteful ways of doing things, she is yet holding a leading place as the world's workshop, need she despair of the results which will follow when she has fully equipped herself according to the latest ideals of economical mechanical production?

It would be foolish to maintain that the phenomenal natural resources of the United States do not give them a permanent industrial advantage, or that there is not a tendency for industrial ascendancy to pass to the land so endowed. The point is that this is not the whole of the case nor the only important consideration. National temperament, adaptiveness, stability of character and institutions, commercial ability, political and economic soundness, all are influential and the result is a product of all the factors. Over confidence in the strength of one's own position and indifference or inattention to the qualifications of rivals are the most disastrous attributes. England is suffering more from her long obliviousness to the possibillty that she could have a formidable rival than she is from the opening of the Minnesota iron mines or the Pennsylvania coal fields. Her awakening has been startling, but promises to be thorough. With her magnificent political stability, her sound economic system, her marvellous commercial system and her dogged courage—and, after all this, with the "cashing in" of her yet unrealised asset of possible labour-economy—she is so far from "decadent" that the suggestion is ridiculous. It is not at all probable that she can retain the wholly disproportionate share of the world's engineering trade she once enjoyed. The demands are now too great for her capacity, developed to its utmost, to satisfy as large a fraction of them as once she did. The United States, Germany, possibly other National "workshops" not yet fully organised, must be called in to share in the stupendous undertaking. But this is anything but retrogression. And next to her own interest in maintaining her position lies America's interest that she should do so, for she is America's best customer and the continuance of that custom depends upon England's retention of her industrial activity and wealth.

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There is immediate and crying need for remodelling British steel-making practice, beginning with the ore in the ground and the system of land tenures under which mines and works are operated. The defects of the present order and their possible remedies, as they appear to an earnest and patriotic Englishman keenly interested in the prosperity of the steel industry in his own country and intimately familiar with the working of the present arrangements, will be formulated in Mr. Phillips' second article on "Britain and Her Competitors in Iron and Steel Making," to appear in our June issue Whether or not his solution be accepted *in toto*, the ills must be recognised and by some adequate means abated.

This done, Britain may still find profitable markets for all she can produce But supposing even American steel, in certain grades and under certain conditions, can be laid down in Britain at a lower cost than it can be made at home. Will not the engineering trades gain what the ironmasters lose? Britain already imports two-thirds of her iron ore. It might mean painful readjustment, but would it mean ruin, to go one step more, and import the raw material a step farther along in the process of manufacture?

The probability of a positive decline in British steel manufactures is not great; but the attempt to avert it by a tariff duty on foreign steel imported into the United Kingdom would simply throw the game into the hands of the United States and Germany. With Britain self-excluded from purchasing the best and cheapest steel on an equal footing, the markets of the world would be wide open to her competitors. Probably they would cheerfully approve the policy, and be quite satisfied with the exchange of fields. America prospered for some years in spite of protection, because of the enormous home territory to be settled, improved, and developed. There were markets for everything the manufacturers could produce, and the general inflation was not disastrous because of the small area of contact with the rest of the world. There is no possible parallel between such conditions and those controlling the industries of Britain. And there is no likelihood that those controlling Britain's fiscal policy will depart from the long triumphantly successful policy of free trade, under which she has again and again adjusted herself to changing conditions and become the world's greatest seller because she has ever been the world's ablest buyer—because she has worked under conditions of assured stability and concentrated her efforts on the thing whose accomplishment yielded the largest proportionate returns.

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In recapitulation, there is no evident reason why the formation af the United States Steel Corporation should menace the trade at home or abroad. It should steady production and prices. It does not cheapen mining, transport, smelting, or steel making. It does charge itself with the necessity of earning a handsome, or at least a sufficient, profit on every ton it can make and sell. It does not eliminate competition, except certain immediate competion which was threatening other interests very important to some of its promotors. A very large porportion of the steel and iron production of the United States remains in the hands of owners outside of the trust—owners of strength and ability. And there is that large element of talent and enterprise, which may be "turned out of a job" in the reorganisation, to be reckoned with somehow. Possibly in this unquenchable and unsilenceable competition lies the strongest saving hope for the continued advance of the art of steel making in the United States.

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In view of the invasion by Germany and America of British markets for steel and iron products, it is interesting to observe that there is one market at least which is fairly well within British control—that of structural material for ship-building. In this industry, as ever before, Great Britian continues to hold her great supremacy, and in this, at home on the Clyde, the Tyne, and the Thames, there will be a market for British iron and steel.

The Navy estimates for construction work amount to £9,003,256, of which about £8,500,000 is for work actually under way, nearly £7,000,000 being for machinery being built by private firms for hulls in Government yards. In addition to this is the great amount of construction work for the merchant marine, a market which includes replenishment of existing fleets and extension for new requirements. All this is practically in British hands, for the German yards are not yet capable of supplying the demands of their own country, and their entrance into British trade is not to be considered.

It is not to be understood that the shipbuilding industry is the only one to which Britain may look for her steel trade, but it is the one branch in which competition is least to be met. In other lines, however, the effects of competition may work much good, if only to stimulate the development of the most modern methods and the greatest economies in manufacture. It never does harm to learn lessons from one's rivals, and it is altogether possible that the close competition between England and America may result in such a further development of Britain's iron and steel industries as to react still more favourably upon the relation of the home industries of structural material and shipbuilding, and to strengthen their position as a bulwark of British industry.

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Among engineering of works of magnitude of recent construction there appears to be a tendency to use the viaduct where ravines are spanned, and to limit the arch to locations in which streams are in the way. It is the opinion of some able engineers, however, that the steel arch, when properly designed and constructed, is really stiffer and more economical than the viaduct, even though the points of support are much farther apart. Indeed, it is for great heights and wide spans that the arch shows it superiority, comparative designs, in which the weights have been carefully worked out, showing a decided advantage for the arch over the viaduct, when depths of 200 to 300 feet have to be spanned.

From æsthetic considerations there are but two forms of bridge which are agreeable to the eye, the suspension and the arch (these being really the one the inversion of the other), while the girder and the cantilever, however correct they may be constructively, are far from pleasing in appearance. It is interesting to observe that in many cases of bridge replacement the new construction has been distinctly more agreeable to look at than the older form which it superseded, and when it can be shown that the form which looks the best *is* the best, there is every reason to feel a sense of satisfaction that the canons of beauty and utility have been obeyed together.

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The summary of the engineering progress of the past century by Mr. Thomas Curtis Clarke, reviewed at length elsewhere in this issue, emphasises a cause of the development of engineering which cannot be too strongly stated. It is the publicity which is given to methods, processes, and results, which enables the modern engineer to accomplish so much more than his predecessor. Under the old system of keeping the knowledge of the profession as an "art or mystery," each man had to learn over again for himself much that his immediate associates knew already, but carefully cherished as a part of their private possession, and the effect of this secretiveness upon the development of the profession was most repressing. To-day the multitude of technical journals and magazines is filled with the open record of the practice of the greatest and ablest minds in the profession. What would formerly have been considered as shop secrets of great value are now printed openly in publications especially known to reach the very men desirous of obtaining such information, and strange to say, the result is a general advance in which all partake, and each receives far more than he gives.

Mr. Clarke especially notes the benefit to the profession of the comparatively modern idea of publishing indexes and digests of the technical articles in the current periodicals, and fully believes in the important part which these have had in recent engineering progress. When consideration is given to the immense amount of labour which can be saved by a judicious use of THE ENGINEERING INDEX, it is a matter for surprise, not that it has been such an efficient aid in developing the work of the engineer, but that it is not far more generally used than it actually is. True, many able men examine it regularly for articles relating to their especial work, and in the card form it is found in some libraries, side by side with the cases containing the periodicals indexed; but in far too many instances this invaluable aid to investigation and the saving of labour is neglected.

When it is realised that by glancing over about thirty pages the whole field of technical literature of the month, including the important articles in nearly two-hundred publications, can be noted, and the special papers in one's chosen profession found, some idea of the help of such a concentrated mass of information is obtained. When, still further, it is understood that the special papers desired can be had upon order, without the necessity of subscribing for any period of time to the publication containing the INDEX, or even doing more than writing a number and an address upon a coupon and dropping it into the post with a sum trifling in comparison with the value of the information obtained, then one begins to understand what it means to have done almost automatically for him what he could never spare either the time or the money cost to do for himself.

"Science," according to the masterly definition of Lord Brougham, "is knowledge reduced to a system." THE ENGINEERING INDEX has reduced the assimilation of the contents of the technical press to a system, and in so doing has contributed in no small degree to the advancement of engineering, upon which so great a share of our material progress depends.

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Another factor which has done much to advance the science of engineering along the line of publicity, so vital to all true knowledge, is the work of the engineering institutions and societies.

Nearly every branch of the profession now has its representative body, and in meetings more or less frequent the great works of members in all parts of the world are discussed and examined. Handsome houses are built to provide meeting places and shelter for libraries and collections, and membership in such institutions is coveted as the mark of professional eminence and standing.

The result of all this has undoubtedly been for good, however strongly opposed it is to the former idea that knowledge was a cult to be maintained as the property of the few. Although membership in recognised institutions is to be had only after the production of evidence of ability and standing of the high standard required, yet the provision of various grades of membership renders it possible for all, who are in any way qualified to profit by the proceedings, to take part in them.

The result has been of immeasurable benefit to the work of the engineer and to the standing of the profession. A century ago, an engineer, in the modern sense of the term, was regarded as little more than an ordinary mechanic, unless by some patronage or especial circumstances he was forced to the front. To-day membership in the great professional societies is in itself a warrant of social standing. At the conventions of the various societies the members have been accorded recognition by royalty and authority in many lands, and within the past few years the interest taken in the work of such bodies by the Queen of England, the King of Sweden, the President of the United States, and the President of France, shows how closely the work of such bodies is related to that of government. With this has naturally come a strengthening of international relations, and the affiliation between the engineering institutions of England, America, France, and Germany has been shown and appreciated at the gatherings at Paris and elsewhere in the past year.

It is freedom of thought which leads to freedom of action, and liberty in engineering matters has truly been the most effective factor in the development of the past century.

REVIEW OF THE BRITISH PRESS

The Water-Tube Boiler Report.

SIX months ago there was noted in these columns the appointment of a special committee by the Admiralty to inquire into the question of water-tube boilers in the Royal Navy, and at that time it was said that there was a possibility that the many conflicting and doubtful reports would be superseded by positive data from which both engineer and layman might draw definite conclusions.

This was followed by the exhaustive study in the issues for November and December, by Mr. B. H. Thwaite, of water-tube boilers in general, with a critical comparison both of the type and of special forms, with the shell boiler. Now we have the interim report of the Admiralty committee, and from the text of the report itself, and from editorial comments by the technical press, we may review the situation as it is officially placed before the public.

At the time of its appointment the committee was instructed to report upon three distinct points; whether water-tube boilers in general were more suitable than cylindrical boilers for naval purposes; whether the Belleville boiler was the best form for the Navy; and, what general advice and information could be given upon the subject of boilers for naval service.

These points have been duly considered in order. Upon the first the committee utters no uncertain sound:

"The committee are of opinion that the advantages of water-tube boilers are so great, chiefly from a military point of view, that, provided a satisfactory type of water-tube boiler be adopted, it would be more suitable for use in His Majesty's Navy than the cylindrical type of boiler."

That is to say, water-tube boilers are all right, if we can only get a good kind. That a good kind has not been already obtained in the Belleville, is also apparent from the statement of the committee on the second point.

"The committee do not consider that the Belleville boiler has any such advantage over other types of water-tube boilers as to lead them to recommend it as the best adapted to the requirements of his Majesty's Navy."

So far as installations already completed, in progress, or contemplated are concerned, the committee recommends:

"As regards ships which are to be ordered in the future: that Belleville boilers be not fitted in any case. As regards ships recently ordered, for which the work done on boilers is not too far advanced: that Belleville boilers be not fitted. As regards ships under construction, for which the work is so far advanced that any alteration of type of boiler would delay the completion of the ships; that Belleville boilers be retained. As regards completed ships: that Belleville boilers be retained as fitted."

This, then, is the finish of the Belleville boiler in the Royal Navy, for there can be no reasonable appeal from such a positive decision, coming from such a high tribunal. Passing then, from the conclusions, it may be advisable to examine somewhat into the facts upon which they are based.

First, as to the superiority of water-tube boilers, over cylindrical boilers for naval use, this is really the most important point in the whole report. It had been practically anticipated that the committee would condemn the Belleville boiler, at least for future installations, but it was feared in some directions that the condemnation of one form might drag down the whole class with it. It appears to be well understood, however, that water-tube boilers may be divided into two classes; one, consisting of the Belleville, the other consisting of all other water-tube boilers. The highest French authority on marine boilers, M. Bertin, divides water-tube boilers into three classes; those with limited circulation, in which he places the Belleville; those with natural circulation, such as the Niclausse, Babcock & Wilcox, etc.; and those with accelerated circulation, such as the Thorneycroft, Yarrow, and other small-tube boilers.

Herein lies the real cause of the unsatisfactory working of the Belleville boiler, its defective circulation. The construction is sufficiently well-known to render this defect to be easily understood. Each element, consisting, as it does of a zig-zag built-up tube about 150 diameters in length, with a restricted water supply at the lower end and a free outlet at the upper, cannot possibly deliver the steam which it can make without carrying with it much of the water. Speaking of the boiler as made in 1869, M. Bertin says: "The boilers were irregular in working, owing principally to the steam not being able to get away with sufficient freedom. The whole of the water was at times forced up from the lower tubes, and on one occasion all the tubes in the lower rows, which were full of steam, became red hot." We have been given to understand that this defect existed with the earlier boilers only, but there is no reason why the same action should not take place with the Belleville boiler as built to-day, and the behaviour of the boilers which have been installed in the Royal Navy, so far as has been made public, indicates that such action is just what does take place. In this matter the report of the committee may be literally quoted.

"The following points in relation to the construction and working of the Belleville boiler to constitute practical objections of a serious nature: (*a*) The circulation of water is defective and uncertain, because of the resistance offered by the great length of tube between the feed and steam collectors, the friction of the junction-boxes, and the small holes in the nipples between the feed collector and the generator tubes, which also are liable to be obstructed, and may thus become a source of danger. (*b*) The necessity of an automatic feeding apparatus of a delicate and complicated kind. (*c*) The great excess of the pressure required in the feed pipes and pumps over the boiler pressure. (*d*) The considerable necessary excess of boiler pressure over the working pressure at the engines. (*e*) The water gauges not indicating with certainty the amount of water in the boiler. This has led to serious accidents. (*f*) The quantity of water which the boiler contains at different rates of combustion varying, although the same level may be shown on the water gauges. (*g*) The necessity of providing separators with automatic blow-out valves on the main steam pipes to provide for water thrown out of the boilers when speed is suddenly increased. (*h*) The constant trouble and loss of water resulting from the nickel sleeve joints connecting the elements to the feed collectors. (*i*) The liability of the upper generator tubes to fail by pitting or corrosion, and, in economiser boilers, the still greater liability of the economiser tubes to fail from the same cause. Further: (*k*) The upkeep of the Belleville boiler has so far proved to be more costly than that of cylindrical boilers; in the opinion of the Committee this excess is likely to increase materially with the age of the boilers. (*l*) The additional evaporating plant required with Belleville boilers, and their greater coal consumption on ordinary service as compared with cylindrical boilers, has hitherto nullified to a great extent the saving of weight effected by their adoption, and, in considering the radius of action, it is doubtful whether any real advantage has been gained."

Among the boilers held under consideration as possibly available for the naval service, are named the Babcock & Wilcox, the Niclausse, the Dürr, and the large-tube Yarrow boiler. Of these, the Babcock & Wilcox is widely known and used in land service, and as modified for marine use appears to be entirely free from the defect of restricted circulation. It has given a good account of itself in some vessels of the American navy, and is recommended by the committee for early trial. The Niclausse boiler also provides for good circulation, and is, in fact a nest of Field tubes placed at a low angle, with good connections for the entrance of water and the discharge of steam. The Dürr boiler is practically identical in principle with the Niclausse, differing in minor details only.

Water tube boilers have not given as good evaporative results as cylindrical boilers, and attempts have been made to improve the performance by the addition of economisers. This method does not meet with the approval of the committee, and the recommendation is very properly made that economisers be abandoned, and that better efficiency be obtained by securing better combustion. This means increased combustion space, and a greater distance between firebars and tubes, a most sensible recommendation.

It is a question whether the small-tube boilers ought not now to be given an opportunity to show to what extent they are available for large vessels. Boilers of the Yarrow and Thorneycroft type are constructed in units of more than 1,500 h. p., and it appears altogether possible that designs originally supposed to be mainly suitable for torpedo boats and destroyers, may yet be found applicable to larger vessels.

It is interesting to note that the committee recommends the use of cylindrical boilers for the supply of steam to the auxiliaries, where a large proportion of the fuel consumption must be charged.

Automobiles in Warfare.

EXPERIENCE with animal traction in recent military operations have called forth various suggestions that mechanical devices might be more effective, and in certain instances traction engines have been satisfactorily employed for hauling artillery and supply trains. In a paper recently presented before the Royal Artillery Institution, Major H. A. Bethell described a form of automobile adapted for field artillery service, and discussed the advantages and defects which such vehicles might possess.

For artillery service, steam appears to be the only motive power at present applicable, and for such service many of the objections urged against steam for ordinary uses do not apply. For rough ground the three-point suspension is advocated, although it is objectionable so far as side-slip on muddy roads is concerned. The running gear should include a powerful slow-speed gear for use on bad ground, and a winding drum and wire rope for use in warping the vehicle out of difficulties. No especially new details of motive power are suggested by Major Bethell, it being assumed that the boilers and engines of such makers as Thorneycroft Simpson & Bodman and others possess all the necessary qualifications.

"For artillery purposes, a motor would be constructed to carry one hundred rounds of ammunition and six men, and the gun would be limbered up to it in the ordinary way. Presumably the gun would be a heavy high-velocity fifteen-pounder quick-firer, with axle-tree shields, similar to the guns now being issued, but more powerful. Waggon bodies similar to the present ones, but carrying one hundred rounds, instead of sixty-four, would be drawn by motors exactly similar to the gun motors, and interchangeable with them. This would give three hundred rounds of ammunition per gun in the first line, and detachments of twelve men per gun besides the drivers. Five other cars, similar in construction, but different in fittings, would carry the five officers, with the range-takers and battery staff. These cars would be capable of pulling guns if required. A battery travelling kitchen, officers' mess car, and an advance and rear guard of cyclist scouts, would complete the turn-out.

"Now if the motor car will do what its advocates claim for it, a battery equipped as above would have many advantages over a horsed battery. It would have more powerful guns, twice as much ammunition, and would carry its own baggage; it would, in fact, be complete in itself. Such a battery could march twelve miles an hour, or one hundred miles a day. It could move nearly as fast as a horsed battery over ordinary European fighting ground, *i. e.,* cultivated fields; it could move at three miles an hour over ordinary rough ground, and only really bad ground, such as a field battery traverses at a walk with detachments dismounted, would be impassable to it. It would require a less number of men than a horsed battery, and cost considerably less; it would also occupy less space on the road when marching"

There are naturally numerous objections to be made to mechanical traction for artillery, but Major Bethell argues that these are hardly greater than those known to exist in connection with animal traction. So far as liability to breakdown is concerned, experience with steam motors has shown that they are comparatively free from breakdowns, and that casualties are almost always due to mistakes of drivers. Sinking in soft ground may be prevented by the use of wide tyres. Danger of disablement in action is proportionally less than with horses, the boiler and vulnerable parts offering about the same exposure to fire as a single horse, while the crippling of three horses which would permanently disable a gun, is about as probable as the hitting of a boiler, and the two are about equivalent. The time in starting is estimated at about five to ten minutes in favour of horses, and in the case of the motor traction the danger due to horses becoming unmanageable is absent.

The first cost of the motor vehicle is estimated as £1,755 as against £2,997 for a team of six horses, both estimates being based on six years' service. The cost of actual operation of the motor vehicle would depend much upon the supplies of fuel and water these being readily available in most places. In waterless districts extra water tanks would have to be included, but the motor vehicle would be far better able tc carry its water supply than would the horse team.

"Up to the present no trials of motors across country have been made, nor have any cars been built with a view to military requirements. No one has asked for them, and it is not the business of manufacturers to build experimental vehicles to meet a problematical demand. But several of our leading car-builders are of opinion that there is no very great difficulty in complying with the conditions proposed; and if the War Office were to offer any encouragement—say, an order to six leading manufacturers for a car each, built to Royal Carriage Department design, modified to suit manufacturing specialties—this offer would find a ready response."

The Electrical Power Bills of 1900.

Last September the subject of the electric-power bills under consideration by the Select Committee of the House of Commons was discussed in these columns, and frequent reference has since been made to the hampering influence which adverse or dilatory official action has had upon the development of electrical undertakings in Great Britain. Referring to the passage of four important bills for such undertakings at the recent session, Mr. W. L. Madgen presented before the Institution of Electrical Engineers a paper examining the conditions of the industry before and after the passage of the bills, with some excellent comments upon the relation of the electrical industry in Great Britain and other countries.

Mr. Madgen shows that it is to no lack of ability that Britain is so behindhand in electrical undertakings, and mentions the work of Hopkinson, Swan, Ferranti, and others to emphasise this fact. The real reason, as he emphatically joints out, is due to silly legislation by Parliament and obstruction by numerous local authorities entrusted with arbitrary powers; and to a class of quasi-officials and their associates to whose direct monetary advantage it is that an opposition should be entered to every project in which they are not employed.

The Act of 1870 with its notorious section 43, providing for the purchase of a tramway at the expiration of twenty-one years at a price based solely upon the instant value, without regard for future profits, etc., effectually stifled tramway development uptil the Act of 1888 gave a trifling relief by extending the period from twenty-one to forty-two years. Electric power distribution is still governed by the Act of 1882, passed at a time when the distance to which energy could be delivered did not exceed the limits of a single town, and when modern supply in bulk over many miles was not possible.

During the six valuable years between 1882 and 1888 Germany and America, under far more favourable conditions, have gone ahead with home undertakings which have given them an experience and equipment which laid the foundations of their great export business in electrical plant and accessories, the consequences of which Britain is now feeling. America and Germany now hold the great bulk of the export trade of this character, not only to the countries of Europe and to South America, but also to British colonies and the United Kingdom itself.

The passage of the four bills of 1900 show a slight sense of comprehension of national backwardness in that, with certain limitations the companies may proceed to do what in other parts of the world they have been encouraged to do.

The absence of great electrical undertakings in the United Kingdom has not been on account of any difficulty or impossibility on the engineering side, or from any lack of suitable conditions, but is wholly due to the causes above mentioned. Mr. Madgen gives in parallel columns the relative advantages and disadvantages of supply from main power houses over large areas and from small local stations, and shows nine distinct advantages for the large stations and two minor disadvantages, while for the local stations there are no advantages to be found, and eight great disadvantages.

It is useless to endeavour to build up a business in Great Britain when such a severe handicap is officially put upon British industries, and it is no wonder that the position of the nation is a humiliating one.

The Efficiency of Marine Boilers.

While the water-tube boiler will doubtless soon become the boiler for naval service, the cylindrical tubular boiler will probably maintain its assured position in the merchant service for a long time. For this reason the paper of Mr. G. M. Brown, upon methods for increasing its efficiency, presented before the North-East Coast Institution, is important. As Mr. Brown says, there has been little done to the cylindrical marine boiler during the past twenty years except to increase its strength to withstand the increased pressure demanded. The marine engine has been improved in many ways, and it is time the boiler had received some attention.

The boiler is intended to abstract the heat from the gases and transfer it to the water to be evaporated. This being the case improvement should be looked for in devices to secure good combustion, and to permit as little heat as practicable to go up the funnel.

Taking up the last point first, it appears that the proportion of heat absorbed by the boiler may be increased in two ways, by increasing the proportion of heating surface, and by rendering certain portions of that surface more effective. Heating surface may be increased in boilers already constructed, by placing feed-water heaters, or economisers, in the uptake, and also by using tubes with "extended" fire surface, such as the Serve tube with projecting internal longitudinal ribs. Such ribs increase the heating surface about 75 per cent., and their use has shown a marked increase in efficiency.

Much of the usual heating surface in tubular boilers is ineffective, and experience has shown that the lower rows of tubes receive but a small portion of the hot gases, the draft tending so strongly toward the upper tubes that the lower ones soon become filled with soot and fine ash. Attempts have been made in stationary practice to improve upon this condition of affairs by making the lower tubes of larger diameter than the upper ones, and Mr. Brown advocates the use of "retarders" in the upper tubes to accomplish the same object.

He gives the results of various experiments made with retarders, from the early attempts of Isherwood, to the recent ones of Scott, the latter showing especially the advantages derived from a proper distribution of the retarders to compel a greater portion of the gases to flow through the lower tubes.

The importance of providing ample combustion space is also emphasised, the advantages of large rear combustion chambers being shown.

In addition to the use of feed-water heaters and economisers, the discharge gases may be employed to superheat the steam, this formerly having been the general practice, and now being effectively revived. Recent experiments on the steamer "Inchmarlo," provided with superheaters, showed a temperature of waste gases of only 380° F., and a consumption of only 0.97 ℔. of coal per indicated horse-power-hour.

Combining good combustion, ample heating surface, and appliances for abstracting heat for the waste gases, there is every reason to believe that high boiler efficiency can be secured.

The Marine Steam Turbine.

The steam turbine has been the object of much attention ever since the early experiments of Mr. Parsons attracted attention to the remarkable results attainable, and hence the paper recently read by him before the Institution of Engineers and Shipbuilders in Scotland, upon the application of the steam turbine to fast vessels, is noteworthy.

Mr. Parsons tells how the steam turbine was originally devised for the purpose of providing an engine of high rotative speed for the purpose of direct driving of dynamos, and as the best turbine speed was too high this also involved the design of a high-speed dynamo.

In the year 1884, a compound steam turbine engine of 10 h. p. and a modified high-speed dynamo were designed and built for a working speed of 18,000 revolutions per minute. This machine proved to be practically successful, and subsequently ran for some years doing useful work, and is now in the South Kensington Museum.

This turbine engine consisted of two groups of fifteen successive turbine wheels, or rows of blades, on one drum or shaft within a concentric case on the right and left of the steam inlet, the moving blades or vanes being in circumferential rows projecting outwardly from the shaft, and nearly touching the case, and the fixed or guide blades being similarly formed and projecting inwardly from the case and nearly touching the shaft. A series of turbine wheels on one shaft were thus constituted, each one complete in itself, like a parallel flow water turbine, but unlike a water turbine, the steam after performing its work in each turbine passed on to the next, preserving its longitudinal velocity without shock, gradually falling in pressure on passing through each row of blades and gradually expanding. Each successive row of blades was slightly larger in passage-way than the preceding, to allow for the increasing bulk of the elastic steam, and thus its velocity of flow was regulated so as to operate with the greatest degree of efficiency on each turbine of the series.

Experience with this early machine showed the advantage to be attained by making larger engines, and in 1888 several machines of 120 h. p. were made, while in 1892 a 200 h. p. steam turbine was arranged to be worked in connection with a condenser. This turbine was tested by Professor Ewing, and with a steam pressure of 100 lb., moderately superheated, and a 28 ins. vacuum, a consumption of 27 lb. of steam per kilowatt-hour was obtained, this corresponding to about 16 lb. per indicated horse power. A number of such turbines have since been made for direct electric driving, and a generating set of 1,200 kilowatt capacity of this type, recently constructed for the corporation of Elberfeld, Germany, showed a performance equivalent to a consumption of 11.9 lb. of steam per indicated horse power, a result surpassing the records of the best steam engines of this size.

Mr. Parsons, however, discussed mainly the application of the steam turbine to marine purposes, and after detailing the early experiences with the Turbina, and discussing the problems of "cavitation" encountered with the action of screw propellers at high rotative speeds, he proceeded to outline the design for the application of the turbine to large liners and cruisers.

A vessel now under construction by Messrs. W. Denny & Bros., of Dumbarton, is 250 ft. long, 30 ft. beam, and 17 ft. 9 ins. depth, and is to be fitted with the following machinery. There will be three turbines, fitted to three separate shafts, the high pressure turbine being on the middle shaft and the two low-pressure turbines on the two outer shafts. Inside of the exhaust ends of the low-pressure turbines are placed the two astern turbines, which operate by reversing the direction of rotation of the low-pressure motors and outside shafts. When going ahead, steam enters the middle, or high-pressure turbine, where it is expanded about five times, and then passes through the low-pressure turbines, in which it is expanded 25 times, thus giving a total expansion of 125-fold, instead of about 16-fold, as in triple-expansion reciprocating engines. Since the outer shafts can be rotated in either direction all the manoeuvring power of a twin-screw vessel is obtained.

This vessel is intended for regular passenger service, in which the full speed will be constantly demanded, but for cruisers, in which a cruising speed, much lower than the economical speed of the turbines will be generally required, a modification is arranged. At cruising speeds, the revolutions of the turbines fall well within the limits of speed of small reciprocating engines, and such engines may therefore be directly coupled to the main turbines, and work in conjunction with them. The small triple-expansion reciprocating engines take the steam directly from the boilers and expand it down to about atmospheric pressure. It then passes to the high-pressure turbine and thence to the low-pressure turbines to the condensers. When somewhat higher speeds are desired, a little boiler steam is admitted to the turbines, and when still higher speeds are demanded and the revolutions become too high for the reciprocating engines, the latter are uncoupled, and the turbines are given full steam and power.

This combination of reciprocating engines and turbines is only needed for cruisers which are operated for long periods at slow cruising speeds. The turbines alone have their full measure of economy from half to full power, and it is only when the cruising speed falls to nearly one-half full speed and the horse power to one-eighth full power, that the economy of the turbines requires assistance. Such a combination is entirely unnecessary for passenger engines and ocean liners.

The simplicity of construction and arrangement of turbine machinery for an Atlantic liner of 20,000 to 30,000 h. p. over that of reciprocating engines is very apparent. The advantages to be realised in actual service may be summed up as follows:

Increased speed for the same boiler power, due to considerably reduced weight of machinery, and increased economy of steam; or, conversely, same speed with reduced boiler power and reduced coal consumption.

Absence of vibration, giving greater comfort to passengers and diminished strains on hull.

Increased cabin accommodation, due to smaller space required for machinery.

Less upkeep in machinery, and smaller engine-room staff.

In view of the extent to which undertakings are now being made to introduce the steam turbine upon passenger vessels, we may soon know from actual experience the extent to which these features can be realised in practice.

Electrical Power in British Works.

Although there have been many papers and articles upon the advantages of direct electrical driving of machinery in workshops, there is always something more to be said, and until the complete or general substitution of electricity for shafting, belting, and gearing is effected the subject will be one for discussion.

A very excellent paper dealing with the question from a practical standpoint, was recently presented before the Gloucester Engineering Society, by Mr. W. Geipel, and published in the *Electrical Review,* from which some abstracts are made.

The older arrangements of power distribution may be classified into three groups; the use of one large engine, with shafting and belting transmission, the use of a number of separate engines, with steam transmitted through long pipes from a central battery of boilers, and the use of a number of boilers and engines scattered over the works. The consequent losses vary according to the system employed.

When a single engine is used, the losses in transmission are those due to journal friction, stiffness of belts or ropes, and weight of material kept in motion. Investigations of many cases in different kinds of work show these losses to range between 14 and 81 per cent. of the total power of the engine, an average for heavy work being 62 per cent. and for light work 52 per cent. When the steam is transmitted long distances to the engines, the losses are those due to condensation in the pipes, and those due to the fact that the small engines are not so economical as a single large engine of equivalent power. The loss in steam pipes may be partly prevented by jacketing, but this is only a partial relief. Mr. Geipel estimates that the loss in pipe condensation is the equivalent in steam of half-a-ton of coal per annum for each square foot of pipe exposed to the atmosphere, while with the best lagging the equivalent is one-sixth of a ton.

Small engines are notoriously wasteful of steam. The average of 100 tests made by Mr. Bryan Donkin was 150 pounds of steam per h. p. hour, or about ten times that which should be required by a large compound condensing engine.

Under these conditions the comparison with electric driving, on the score of economy of power alone may be considered. Although higher efficiencies have been obtained, Mr. Geipel conservatively places the efficiencies in electric driving as follows:

Generators	92 per cent.
Conductors	98 per cent.
Motors	85 per cent.
Total Efficiency	76 per cent.

"That is, at full load, 76 per cent. of the power on the engine shaft is delivered at the shaft of the motor; deducting the friction of the engine, which will absorb, say 10 per cent., we then have 68 per cent. of the indicated horse power of the engine delivered at the motor shaft; at three-quarter load it would be about 65 per cent. and at half load about 60 per cent. The efficiency of the electric machinery may vary slightly according to the design and the state of the load, but the above results may be taken as a fair average." It will not be far out to take two-thirds of the indicated power of the engine as delivered at the shaft of the motor.

Under the above assumptions Mr. Geipel proceeds to consider the reduction in the various losses when electric driving is substituted for shafting and belting, etc.

With the introduction of electric driving all heavy shafting is avoided, heavy tools having their own motors, while light tools are best arranged for group driving, a short length of shafting being driven by a motor and the power distributed to the tools by belting.

Thus the loss in shafting is avoided for heavy tools, and minimised for light ones. It must be remembered that when the motors are switched off there is no loss, while in the case of shafting the loss is a continuous one, a most important consideration for machinery working intermittently. In many instances the hours of actual machine driving are fewer than one-half the shop time, and with electrical driving there is a corresponding saving in transmission losses.

The loss in electrical conductors is much less than that in steam pipes, and with proper sizes of mains can be kept down to 2 per cent., besides which there is no loss except when the conductors are actually in use.

The steam economy is that due to the superior efficiency of large engines over small ones. As has already been shown, the consumption of steam in small engines, from tests by Mr. Donkin, average about 150 pounds per h. p. hour, while for a large, well constructed engine it may be as low as 16 pounds. Taking 68 per cent. delivered at the motor shaft, the steam charge for electric driving would be about 24 pounds per h. p. hour, so that there should be a saving of more than 100 pounds of steam per hour. Boiler evaporations range from 6 to 9 pounds of water per pound of coal, and Mr. Geipel assumes that a saving of 10 pounds per h. p. hour is a reasonable figure.

There are a number of minor economies resulting from the use of electric driving, but after all the greatest advantages are found in the increased output and in the greater convenience in arrangement of machinery.

Delays from slipping of belts, hot bearings, and local breakdowns are avoided, since any accident in one part of the works has no influence upon the rest of the machinery, while the better regulation and increased working speed possible, unite to produce the increased output which is invariably ascertained wherever electric driving is adopted. The improved disposition of machinery is a most important feature in economical working, since all tools can be placed with a view to the most advantageous operation rather than with regard to the location of line shafting. In one instance the introduction of electric driving enabled 4,000 men to do the work formerly requiring 6,000 men.

Mr. Geipel goes at length into the general arrangement of generators, motors and distribution, and concludes with a summing up of the advantages of electric driving, which in his opinion will effect a saving capable in most establishments of paying for the cost of installation of the electric plant in two to five years.

The various advantages are:

Absence of overhead shafting, which requires special construction of shops, and causes vibration, dust and dirt.

Absence of belts, dust arising therefrom, repairs necessary thereto, and shadows.

Clear head room for the use of electric cranes and hoists.

Better light and cleanliness.

Regularity of speed of machinery, and saving in wear and tear.

Placement of machinery to facilitate handling of work.

Easy application of motors for special tools, such as keyseating, cylinder boring, air compressing, etc.

Facility of running one or two machines without the rest, for working overtime.

Special suitability for working cranes and lifting apparatus.

Ease of extension.

Utility for electric lighting and other purposes.

General flexibility of the system.

Increased output.

REVIEW OF THE CONTINENTAL PRESS

The Metropolitan Railway of Paris.

We have already given space in these columns to review of the constructive work upon the underground railway in Paris, called the "Metropolitan," and now we have an account of the experience which has been obtained in the operation of the portion already completed.

M. A. Dumas, in a recent issue of *Le Génie Civil,* describes at length the completed section, running from the Porte de Vincennes to the Porte Maillot, that is, directly across and beneath Paris. This section was opened to the public on July 19, 1900, and hence had been in service more than six months at the time of which M. Dumas writes, but the data upon which his account is based extend only to the close of December.

The general construction of the Metropolitan has been so often described that no attempt will be made to do so again at this time. It is sufficient to state that the portion now under consideration is about 6½ miles long, double-track underground, with eighteen stations situated at the busiest points of Paris.

The tractive power is electricity, on the third-rail system, the service consisting of trains of one motor car and three or four trailers, running at a headway of three minutes between trains, the entire run from the Porte de Vincennes to the Porte Maillot being made in 30 minutes including stops, this requiring a maximum speed of 18 to 20 miles an hour. The stops, now that the operators and the public have become accustomed to the road, are about half-a-minute in duration.

During the five months for which reports have been made public, the road has fully demonstrated its success, the total number of passengers having risen from 1,703,301 in August, 1900, to 3,447,241 in December, the receipts for the latter month being 587,000 francs. The number of passengers shows a steady rise from August to December, thus demonstrating that the travel was in no way due to the Exposition, but represents the natural movement of population. The total number of passengers carried for the period from July 19th to December 31, was 15,890,528, corresponding to the receipt of 2,694,563 francs; about 75 per cent. of the travel being second class. The price of tickets is 25 centimes for first-class and 15 centimes for second class, the only apparent difference between them being that the seats of the first class carriages are of leather, while those in the second-class are of wood. Tickets to go and return are also issued at 20 centimes, second class, these nearly equalling in number the total of first-class tickets for the period named.

These figures speak for themselves as to the popularity of the road, exceeding as they do the traffic of any other existing railway. The London Central, nearly of the same length, and started almost at the same time, carried 14,500,000 passengers up to December 31, 1900. Taking the figures obtained for the months of January and February, 1901, it is estimated that the traffic corresponded to a movement of more than four millions of passengers per kilometre per year, or about 2½ million per mile per year!

The carriages hold 30 seated persons and 20 standing, although many more often crowd in, despite the efforts of the guards, and it has already become a question as to how the capacity of the road is to be increased. Two methods are available, to diminish the distance between trains, and run them on a 2 minute headway instead of 3 minutes, or to increase the length of the trains. The reduced headway would increase the capacity only 50 per cent., and would greatly increase the difficulties of operation. The latter method permits a doubling of capacity as a maximum, trains of eight to nine cars being the greatest number which can be received at the platforms.

The present motor carriages, provided with two motors of 100 h. p. each, cannot haul more than three additional cars up the grades, and hence the longer trains would require two motor cars, preferably arranged to be under the control of a single operator. It is possible that the road will ultimately be operated entirely with motor cars, so that trains may be made up of any length as the traffic may demand at various hours.

The demand for tickets, and the necessity for keeping an accurate register of the number of passengers as a check upon the receipts, has led to the use of an ingenious ticket-printing machine.

The machine consists of a stand containing four little printers operated by an electric motor in the base. Three of the machines are arranged for printing the three kinds of tickets, the fourth being a reserve in case of accident. The mere pressing of a handle in front of each machine causes a ticket of that class to be printed and delivered to the operator, who is also the ticket seller, the tickets being printed only as sold and the machine automatically keeping count of the number printed, so that the difference between the readings at the beginning and end of the day gives the total sales immediately. The apparatus works very well, the ticket sellers being women.

M. Dumas gives some account of the construction and operation of the Hall automatic signal system, used on the road, and also describes the new Bercy power house recently completed for the supply of current to the Metropolitan.

The Poulsen Telephonograph.

SINCE the original invention of the phonograph by Edison there have been continual improvements, all tending toward the more satisfactory recording of the original vibrations, or towards the more accurate interchange of records. The most important of these improvements is that recently brought by a Danish electrician, M. Waldemar Poulsen, which attracted much attention at the Paris exposition, and formed the subject of an interesting paper by Mr. Jul. H. West, presented before the Electrotechnical Society of Berlin, and published in the *Elektrotechnische Zeitschrift*.

As is well-known, the phonograph makes its record by the indentations produced by a stylus attached to the under side of the diaphragm and bearing upon a surface of wax or soft metal; and this appears in the peculiar metallic tones of the reproduced sounds, the more delicate vibrations being much deadened. The sound is also reproduced directly upon the diaphragm of the instrument, and can only be transmitted to points within the reach of the hearing, aided by such trumpet or megaphone attachments as may be applicable.

In the telephonograph, however, the record is a magnetic, instead of a mechanical one, and it is this ingenious modification which has not only greatly improved the character of the record and its reproduction, but also greatly extended its range.

It is well known that steel is capable of permanent magnetisation, and that the degree of magnetization depends upon the magnetic field to which it is exposed. If, therefore a steel wire or ribbon has moved along its length an electro-magnet subjected to a varying current, the wire will be magnetized to a corresponding extent. Conversely, if an electro-magnet be moved along a wire which has been thus magnetized, it will reproduce a correspondingly varying current, and this current, passing through a telephone receiver, is converted into audible sounds.

In the telephonograph, a steel wire is wound in a helix upon a cylinder, with a clearance space between the coils, and a small electro-magnet is caused to traverse axially along the spiral in such a manner that its poles are close to the wire, although not in contact with it. The current from a battery passes around the poles of the magnet and also through the circuit of a telephone transmitter, and when the transmitter is spoken into, the variations in the current cause corresponding variations in magnetization to be produced in the wire. When the operation is reversed, the magnetized wire produces the vibrations in the diaphragm of the telephone receiver, and the message is reproduced with a far higher degree of accuracy than has ever been possible with any form of mechanically produced record. Such a record possesses many advantages, apart from its superior faithfulness to the original. In the first place there is practically no wear upon it, and experiments have shown that there is no appreciable weakening after 10,000 repetitions of a record. As there is no contact between the wire and the magnet, there is no difficulty in regard to interchangeability, and the wires can readily be sent to any place and used on any machine. If it is desired to obliterate the record it is only necessary to pass the wire before the poles of an electro-magnet receiving a constant current, and the wire becomes a blank, ready to receive a new message.

Mechanical modifications of the principle will readily suggest themselves, and many varieties of the device have already been worked out. The apparatus is being carefully studied in the electrical laboratories of the makers, the firm of Mix & Genest, of Berlin, and some of these special forms were shown by Mr. West. Instead of using a cylinder, the wire or band may be wound from one spool to another, and any number of transmitters may be placed over the wire and be connected to telephones at various points. This arrangement has been adapted for the continuous transmission of intelligence to a number of subscribers, in a manner similar to the stock telegraph instruments. If the record is not to be preserved, the wire may be a short endless piece, led around two sheaves, passing first under the magnet connected with the transmitter, into which the information is spoken, and then under as many magnets as there are receivers to be served. On the return portion the wire passes between the poles of a magnet receiving a continuous current, the record thus being obliterated, and the endless piece made ready again for the transmitter.

Another application of the telephonograph is that of a telephone relay for long-distance lines, the record made at the end of one section being delivered into the transmitter of the next, and so on, indefinitely.

In view of the remarkable results which have thus far been obtained with the telephonograph, it appears as if many of the hopes produced by the original appearance of the phonograph may now be realized.

Practically perfect reproduction of articulate speech and musical sounds, over long distances, is assured. The indefinite multiplication of transmissions is accomplished, as well as absolute interchange of records without deterioration. The record is not susceptible to mechanical injury, rust or friction having no influence upon it, magnetic action being the only thing which changes it.

With all these advantages, it appears that the problem of the transformation of the phonograph from an interesting toy into a commercial apparatus for the recording and transmitting of intelligence is in a fair way to be solved, if that solution has not already been fully reached.

The Brittleness of Steel.

The method of M. Fremont of studying the deformations of a metal under stress by scoring the test piece with cross lines and observing the change in the position of the lines when the piece is bent, has already been noticed in these pages. A practical application of the method is seen in the experimental study of the causes of brittleness in steel made by M. Fremont by the aid of his method, and published in a recent issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale.*

It is well known that certain irons and steels may give results which appear very satisfactory in tension tests and yet fail altogether under bending. It was to examine the causes of these peculiarities that M. Fremont undertook his investigations.

Taking two specific cases, M. Fremont gives the data of several independent tension tests, showing the elastic limit, ultimate resistance, elongation, and reduction of cross-section; these data showing the specimens to be altogether satisfactory, and the curves shown on the recorder of the testing machinery were altogether similar in character. Specimens of the same two steels, when subjected to the bending test, however, showed a marked difference. One test piece, the one which showed the greater ductility under tension test, broke abruptly with only one-half the quantity of work shown by the other, while neither exhibited nearly so high resistance under statical bending test as a third specimen, of which the tensile test gave closely similar results to those of the first two.

Such results are even more marked under the drop test, as photographs of several specimens indicate, and altogether there appears to be every indication that something more than an ordinary tension test is necessary in order that the brittleness of a specimen may be determined.

It has been assumed by some investigators that the suddenness with which the load is applied is largely responsible for these differences, and within certain limits the effect of a blow can be clearly distinguished from an equivalent effort more slowly applied.

This, however, is by no means able to explain the facts, for the difference is often very slight, and M. Fremont shows specimens in which the difference between the effects of slow bending and a sudden drop cannot be distinguished.

In order to study just what really takes place the effects of a gradual bending test may be made visible. If the specimen be polished and properly illuminated, it is quite possible to see upon the surface of the metal the action of the internal forces, and M. Fremont gives a photograph showing very clearly the behaviour of the metal. The deformations may be separated into two elementary kinds, one being a depression and the other a swelling. The areas affected are practically elliptical in shape, and in a pliable specimen they partially neutralise each other, causing such a distribution of stresses that a bending without rupture is effected. In the case of a brittle steel the area of swelling is almost entirely absent, and the tension being concentrated in the lower edge of the specimen, rupture takes place suddenly. For intermediate qualities the results are correspondingly modified.

In order to explain the nature of these actions M. Fremont takes the cases of bars which have been provided with swellings corresponding to those produced by the compression of the normal test piece, and shows how the line of fracture is diverted by reason of the increased section at certain points, and then, from an examination of the behaviour of the specimen under compression, it can be seen to what extent these conditions obtain in actual practice.

It is in such studies that the applicability of the method of M. Fremont appears for regular testing. Briefly, his method consists in scoring the bar, always a small one, with parallel lines at right angles to its length, and consequently parallel to the directing of the applied force in a bending test. As the bar is bent the deformations taking place in it are indicated by the forms assumed by these lines, and it is plainly seen that instead of the theoretical distribution of compression and tension below and above a neutral axis, there is a neutral plane formed which is neither parallel to either face nor at a uniform distance between the faces.

According to numerous tests of this sort made by M. Fremont, it appears that the brittleness depends upon the location of the compression and tension deformations. If the deformation by compression is relatively slight the greater portion must be made by the tension, and if this tension is localised near the surface, rupture readily occurs.

The experiments show that a complete knowledge of the resistance of a metal cannot be obtained by either tension or compression tests alone. Both are necessary, while the bending test, in which both are united, enables a better knowledge to be obtained than is possible by any single test which can be applied.

The Development of Reinforced Concrete.

The combination of iron or steel construction imbedded in concrete has now been in extensive use for about ten years, and during that time it has steadily gained in favor and application, the only unsuccessful instances having been those in which the principles were unknown or wrongly applied. The Paris exposition contained many examples of its use in building construction, and all over Europe the use of reinforced concrete, as it is generally called, is well known.

In recent issues of the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines* there is given a very complete review, by Herr F. von Emperger, of the development of steel and concrete construction, showing the increasing application of the system in recent years. An interesting feature in this development is seen in the extent to which it involves a return to masonry construction, formerly considered to be largely superseded by steel and iron framed structures.

Herr von Emperger begins by giving a number of illustrations of structures at the Paris exposition, showing the numerous examples of the reinforced concrete construction there employed, and then passes to the various detailed methods, distinguished by the name of systems, and really differing from each other only in the arrangement of the metal reinforcement within the concrete.

The fundamental principle involved in all the systems is the combination of the two materials so that the metal may resist the tension at the same time that the concrete opposes the compression stresses, and it is important that the two materials should oppose their elastic resistances to the stresses proportionally, at least to such an extent that they may mutually reinforce each other under the applied loads.

Without going into the details of the various systems fully, the reader being referred for this to the original papers, it must be remembered that the fundamental advantage of the whole method of construction is economy. That is, economy in actual cost, and not necessarily economy of material, although in most instances they go together. In nearly every system the effort is seen to be the employment of as simple a metallic structure as possible. Either sheets of wire netting, or expanded metal, or some equally simple metallic skeleton, is extended between the supporting points, piers, beams, or the like, and the whole imbedded in a mass of concrete; or else beams of concrete containing imbedded rods or cables support flat floors of sheet concrete, also containing imbedded rods, the members being connected or separated by light pieces of hoop iron, or hooked rods, as in the Hennebique system. The Melan system, intended for arches only, uses a skeleton arch of some suitable structural shape, designed to suit the opening to be spanned, and forming a distinct structure within the concrete. In other cases twisted rods have been used to form the metallic portions of the structure, while piers and pillars have been made of old rails and similar material.

Herr von Emperger calls attention to the fact that the whole subject should be made a matter of intelligent engineering design, and that, instead of advocating this or that "system," the structure should be designed to conform to the conditions obtaining, and the tensile and compressive stresses distributed so as to be properly sustained by the respective materials.

An important feature is the quality of the materials composing the concrete, and it must not be assumed that any inferior grade of cement will serve for reinforced concrete construction. It is especially desirable that the concrete should be elastic, in order that it may permit the tensile stress to be sustained by the metallic portion before the concrete has become excessively strained or cracked. This point is necessarily involved in the proper disposition of the metal, and hence it is that the mere placing of some sort of a metallic skeleton in the midst of a mass of concrete is by no means a proper execution of the idea of reinforcement. In other words, the whole construction differs in no sense from other engineering work; it is "common sense applied to the use of materials"; and a high degree of common sense, and a good quality of materials are both as necessary in this as in other lines of work, if success is to be assured.

Water Gauge Glasses.

NOTWITHSTANDING the attempts which have been made to provide automatically for the maintenance of the proper water level in steam boilers, it has never been considered advisable to omit the provision of hand appliances for ascertaining the water level, and all boilers are equipped with gauge cocks and glass water gauges.

In the early days of steam engineering the low pressure used made it a simple matter to provide satisfactory water glasses, but with the high pressures now in general use this is not only more difficult, but the consequences of breakage are more serious. For these reasons the experiments which have been conducted in the Jena laboratories by Herren Schott and Herschkowitz, upon various kinds of tubes for gauge glasses, are of present interest and value. A detailed account of the investigations is published in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieur,* from which some abstracts are here made.

The tests to which the tubes for water gauges were subjected were: resistance to hot and cold pressure; freedom from injury by changes of temperature; and liability to corrosion by the water of the boiler. The glasses tested during the present experiments included the regular French and English water-guages tubes, the Scotch glass tubes, and several varieties of glass made at the Jena works, including the standard Jena combination glass, the hard glass tubing used for ultimate organic analysis, and a new boro-silicate glass called "Durax," intended especially for water gauges.

The tubes tested were from 18 to 20 millimetres outside diameter and from 2 to 3.5 mm. thick. Under cold-water pressure, applied slowly by pump, the bursting pressures ranged between 170 atmospheres for the French glass to 333 atmospheres for the boro-silicate glass the Scotch tubes standing between and breaking at 249 atmospheres. These figures are all so much higher than any pressures employed in actual service that there is no need for comment in this respect.

An interesting feature in these tests was the fact that when the tubes were thoroughly annealed the resistance was not so high as when only partially annealed. The condition of the glass was ascertained by the use of the polariscope, which indicated the internal stresses. It appears that when the glass is not fully annealed there is a tension in the outer layers of the tube, corresponding to the initial stress in a hoop shrunk on a gun, and this assists in resisting the pressure from within.

An important portion of the tests was that relating to the resistance of the various tubes to the sudden application of cold spray on the outside when subject to hot pressure within. This is a condition which frequently occurs in actual service, when dripping water or spray is blown against the gauge glass. The apparatus was so arranged that the operator could observe the tube under test while protected by wire gauze and thick glass from the flying pieces. The pressure and temperature of the water in the glass were both under control and observation, and the investigator could direct the spray upon the outside of the tube at will. Under this test the Jena glass showed a distinct superiority, the French and Scotch tubes breaking at pressures of 6 to 8 atmospheres, while the Jena glass resisted pressures up to 15 to 25 atmospheres.

The question of the internal corrosion of gauge glasses is one of importance both because of the reduction in strength and also because of the obscuration of the visibility of the water level. Chemically pure, distilled water has a varying action upon glass according to the composition. The various tubes were tested by permitting condensed steam to trickle through them for a period of 50 hours, the tubes being weighed in a chemical balance before and after the operation to ascertain the loss in weight. This loss ranged from 8.84 milligrammes per square centimetre in the case of the Scotch tubes to 1.32 milligrammes in the case of the boro-silicate glass. In an 0.5 per cent. soda solution, and in a 0.1 per cent. soda lye solution the boro-silicate glass was much more actively attacked, and the Scotch glass was less acted upon. These facts should be kept in mind in the case of boilers which are not supplied with pure water as the use of certain precipitants as scale preventers may have something to do with the corrosion of gauge glasses in some cases.

In connection with the laboratory tests of gauge glasses it is interesting to observe the extent to which the conclusions are borne out. It was found that in tests of 600 to 700 hours' duration at pressures of 6 to 8 atmospheres, the loss in weight per square centimetre was about 6 milligrammes for the boro-silicate glass and about 9 millligrammes for ordinary glass, when no scale preventive was used in the boiler. When soda was used, the loss in weight was much greater, ranging from 15 to 25 milligrammes.

Some interesting details are given of the apparatus employed in the experiments by which reliable results were obtained without danger of injury to the investigators.

A New Type of Arc Lamp.

Ever since the time of Sir Humphrey Davy the electric arc has been produced in practice for lighting between carbon points, although arcs have naturally been produced experimentally and accidentally between many other substances. The objections to carbon are several, the principal one being the cost and trouble due to the frequent necessary renewals.

The invention of the Nernst incandescent lamp showed the high luminous power obtained when refractory metallic oxides are rendered incandescent by the heat of the electric current, and this principle has now been extended to the arc lamp by Herr Ewald Rasch, whose experiments are described in a recent issue of the *Elektrotechnische Zeitschrift.*

Instead of using electrodes of carbon, which are rapidly consumed, Herr Rasch employs rods of refractory material, such as the oxides of magnesium, thorium, zirconium, etc. These substances, when cold, are non-conductors, but when warmed, as in the case of the Nernst lamp, they permit the current to flow, and when the arc is established, the heat maintains the conductivity. The preliminary heating is more simply accomplished than in the case of the Nernst lamp, an auxiliary arc being employed, the electrodes of this heating arc serving also as leads for the main arc.

Apart from the great advantage of employing permanent electrodes which require no renewal, the new lamp possesses a far higher efficiency than the carbon arc, the light emitted by the incandescent electrodes being much greater than with carbons. This is due to the high concentration of energy at the white incandescent ends of the electrodes, amounting to 30 to 40 watts per square millimetre, and more. The limit in this respect is only reached when the very high melting temperatures of the available materials are reached, such as the most refractory substances, say the metallic oxides, borides, silicides, carbides, etc.

The light emitted by this arc lamp differs materially from that of the Nernst and other incandescent lamps in that the spectrum is not continuous, but consists of various bands, according to the composition of the electrodes. Thus with electrodes of magnesia or zirconia a sun-white light is produced, the illumination being due not only to the incandescent rods themselves, but also to the minute particles electrolytically transferred from one terminal to the other. By the use of other materials, such as oxides of chromium or of nickel, lights of various colors may be produced, and brilliant effects obtained.

In the course of his experiments, Herr Rasch discovered that different materials possess varying availability for use as electrodes, and he classifies them according to their resistance and according to the temperature at which they permit the starting of the arc. Those electrodes which have a high resistance when cold also require to be heated to a high temperature before the arc can be started, and these he calls "hard" materials, while those with a lower resistance and a lower starting temperature, he calls "soft." Although the latter are more convenient as regards starting, they do not stand so high a temperature before fusion, when the arc is closed by the fused material. The hard electrodes give a better light and are more efficient, and hence well worth the additional heating which is required before starting.

Herr Rasch gives data and results of many of his experiments, showing the high efficiency of this new form of arc lamp, the results being plotted in curves. With electrodes 5 millimetres in diameter, and a current of 40 volts and 5 amperes, an average horizontal illumination of 900 Hefner candles was obtained.

The following comparative table, given by Herr Rasch, shows the superiority of the improved arc:

	Hefner Candles per Watt.
Incandescent Electric Lamp.......	0.29
Nernst Incandescent Lamp........	0.66
Arc Lamp, Alternating Current...	1.25
Arc Lamp, Continuous Current....	2.00
Rasch Arc Lamp..........	3.00 to 4.00

This shows the new lamp to be practically double the maximum efficiency of the carbon arc lamp, apart from the great advantage of the permanency of the electrodes. The disadvantage of the necessity of preliminary heating must, of course, be considered, but as this may be accomplished in several simple ways it does not appear to be a serious difficulty.

Doubtless the new lamp will become the subject of extensive experiment, and should its practical advantages correspond to those obtained in the laboratory it will prove an important addition to the practice of electric lighting.

Although the precise details of the composition of the electrodes preferred by Herr Rasch are not made public, pending the completion of the patents, yet their general nature can be readily imagined, in view of the knowledge which has been obtained from the study of incandescent gas-mantles.

The Power Plant at the Paris Exposition.

An important contribution to the technology of power-plant construction and administration is found in an exhaustive paper upon the power installations at the Paris exposition, presented to the *Société des Ingénieurs Civils de France,* by M. Charles Bourdon, the chief engineer of the service, and published in the *Mémoires* of the society.

The paper contains many valuable details, covering the mechanical, electrical, and hydraulic plants, as well as the apparatus for handling materials, all of which came under the general division of the mechanical service of the exposition, and for these details reference must be had to the original paper, as only a general outline can be given here.

The general arrangement of the power house has already been described many times, and it is sufficient to remember that it extended entirely across the width of the Champ de Mars, with a tall chimney at each end, the boilers being arranged in double row, and the whole covering an area of 350 feet by 92 feet. There were 92 boilers in all, supplying about 500,000 pounds of steam per hour.

Owing to the arrangement of the steam engines, mainly in large units, in the portion of the buildings adjoining the boiler house, and the fact that nearly all the power was electrically distributed, it was possible to run all the mains in underground tunnels, giving access to the steam and water pipes at all times without disturbing the surface. M. Bourdon gives some interesting details as to connections, expansion joints, drainage, etc., in this connection which will doubtless be found applicable in permanent plants.

As already indicated, nearly all the power was electrically transmitted, but in the section of machine tools, and in the department of textile machinery, there was a partial demand for shafting, this being supplied by short lengths operated by separate motors, less than 5 per cent. of the total power being thus distributed. In fact, the absence of overhead shafting and belting formed one of the most characteristic differences between the exposition of 1900 and all its predecessors, and it thus clearly indicated to transformation which may be generally expected in industrial power plants in the immediate future.

The total power required for the service of the exposition was about 20,000 horse power, of which about 5,000 h. p. was for operating machinery and for other mechanical purposes, and the remaining 15,000 h. p. was for lighting. The plant also included an extensive hydraulic installation, the water being taken from the Seine by a special installation of Worthington pumping engines and delivered to the power plant, the supply being about 1,200 litres per second (about 42 cubic feet per second). The exposition was also authorised to take 300 litres per second, (about 10 cubic feet per second) from the city water supply.

An interesting portion of M. Bourdon's paper was that relating to the handling of exhibits, etc., the cranes and hoisting machinery being so arranged as to form exhibits themselves. Besides the cranes there were a number of elevators, operated by water under high pressure, this water afterwards being discharged into the cascades of the Chateau d'Eau, and falling gradually into the lower basin, where is united with the low pressure water supply which was delivered to the condensers of the low-pressure steam engines.

In connection with the boiler plant, the connections of the smoke flues from the various boilers to the tall chimneys, form an interesting study. The flues were so divided as to give the distant boilers as strong a draft as those closer to the chimneys, and also to prevent the draft of any battery of boilers from being affected by those of the other boilers. To enable any desired combination to be effected, several flues were arranged side by side, with connections to the main flues which could be regulated by metal covers, the cross section being thus kept fairly proportional to the volume of gases delivered. An inspection of the flues at the close of the exposition, after seven months of continuous operation, showed a deposit of about 20 inches of cinders at the base of the chimneys, this deposit extending only about 10 feet back into the main flues, the remainder of the passages being entirely clean, showing the uniform distribution of velocity.

The whole paper contains much of interest to the power plant engineer, and forms a valuable addition to the literature of steam engineering.

REVIEW OF THE AMERICAN PRESS

The River and Harbor of Chicago.

Since the completion of the canal connecting the Chicago river with the Mississippi the results of that important engineering work have been generally discussed from various points of view. At a recent meeting of the Western Society of Engineers the matter formed the subject of comment from a number of engineers, among whom may be named Messrs. L. E. Cooley, P. B. Weare, Isham Randolph, Captain J. G. Keith and others. From a publication of the discussion in the *Journal* of the Society the following abstract is made:

The canal was intended to reverse the current of the Chicago river and cause the flow to carry the sewage and other drainage into the Mississippi, instead of Lake Michigan, and thus prevent the pollution of the water supply drawn from the lake, as well as to replace the foul water of the river with an unobjectionable supply.

Permission was obtained from the United States government to make this diversion, under the condition that the current in the Chicago river should not exceed a mile and a quarter an hour, and that it be not used to the detriment of commerce. At the same time the law requires that on the present basis of 1,700,000 population, not less than 340,000 cubic feet of water per minute be carried out of the sanitary district, and that this volume shall be increased by 20,000 cubic feet for every 100,000 inhabitants. In addition to these points, it was provided that in case the general government should undertake the improvement of the Des Plaines and the Illinois rivers, the sanitary district should complete the channel with a capacity of not less than 600,000 cubic feet per minute.

This latter provision is intended to provide for a waterway through the state of Illinois, and is provided for under a contract between Chicago and the Illinois valley which cannot be set aside.

On the other hand it is found that the flow of even 225,000 cubic feet of water per minute through the Chicago river creates a current which makes it both difficult and dangerous to handle large boats in the river, and when, experimentally, 322,000 cubic feet per minute were put through it produced such a current that the docks were exposed to excessive wear, and navigation became so dangerous that insurance could not be obtained on vessels. At no time has the quantity of water been put through the river which the law requires and yet the detriment to commerce forbidden by the National government has been distinctly produced.

The natural result of this state of affairs has been that the heavy traffic of the river, notably the grain traffic, is being diverted to South Chicago, to Milwaukee, to Waukegan and other points. The importance of this matter, apart from the compliance with the legal conditions, is well stated by Mr. Weare when he stated that it was the lake and the river which had made the commerce of the city and not the railroads. The railroads came because of the canal, and river, and harbor, and if the trade was diverted to other points the position of Chicago would be lost and the city would become a mere way station.

Apart from these considerations, the desirability of the ship canal is undeniable. It is not only a duty to the population upon the Illinois river, but it is also a most desirable thing for Chicago. There are millions of dollars worth of trade in the great lakes which would be released by such a canal, and it is probable that it will be a reality in the next decade.

The injurious effects of the present current in the Chicago river were forcibly stated by Captain Keith. The government says that there shall not be a current of more than 1¼ miles an hour, while at the present time it is not less than 2 miles, and more frequently 3 miles per hour. Vessels have been damaged to the extent of $800 to

$1,200, and the costs for towage range from $200 to $400, as against $5 to $10, at competing ports.

The natural solution of the difficulty lies in the deepening and widening of the Chicago river, that is, the increase of the cross section in order to reduce the velocity. This again involves large expense both for construction works and for damages, and so the whole problem requires time and money, and while the time is passing the commerce is slipping away.

That the commerce of a great city like Chicago will be permitted to be ruined for causes which can be remedied by engineering skill cannot for a moment be conceded, but the whole subject is an interesting lesson of the manner in which the unexpected often happens.

Now that the drainage channel has been opened and the current in the river has been produced, it is evident to any one that it is just what might have been expected; but yet no one foresaw what is now such an obvious result. The river must be improved, the commerce of the city must be saved, and it will cost nearly as much as the whole cost of the channel to do it, apart from the time lost during the operation, but in the end the advantages will far outweigh the cost, both in time and in money.

The Relation of Steam and Electric Roads.

THE tendency to assume that there is some especial vested right in any branch of industry to those who have enjoyed sole possession of it for a long time, is very strong, and somehow there is a feeling of injury in the minds of such, when they perceive some invader into their domain. Doubtless just such a feeling exists in the minds of many railroad men when the question of the development of electric roads is mentioned, and it seems in many instances to be assumed that inter-urban electric roads are somehow poachers, so to speak, upon their own private business. The days when railways supplanted stage coach lines has been too long past for railroad men to realize that there was a day when they occupied the position of invaders, and so the old subject comes up again repeatedly, as if it were always a new one.

In a recent issue of the *Street Railway Journal* the question of the relation between electric and steam roads is discussed editorially in an interesting manner, and the importance of the subject renders it one appropriate for comment and review. The present situation is very clearly stated:

"The first office of the electric motor was to supplant the horse in the operation of purely street railways—mainly in cities—and uncomplicated by the keen demand for rapid transit, which has been the impelling force in the progress of electric railroading. So long as the art followed strictly in this narrow channel, one might broadly say that the electric railways had no particular relations with the steam railways, whose function—for the most part—was distinctly different, and which, save in the few elevated structures then in use, did not come into direct competition with tramway systems at all. As, however, the possibilities of electric traction began to become evident, the electric road passed very rapidly from being an improved tramway into a position differing radically both from tramways as they had been hitherto known, and from the ordinary means of suburban or interurban service. At the present time, not only has the electric road supplanted the horse, but it has supplemented the previous work of the steam suburban roads, and is already beginning to actively enter into competition with steam roads—not only in interurban service, but even in the heavier traffic which pertains to trunk lines."

Apart from the difference in the motive power, the electric tramway has a very strong hold upon popular favor because it carries him very near where he wishes to go, instead of delivering him at some arbitrary station from which he has more or less of a distance to go before his journey is completed. People do not, and in most cases cannot live on the line of a steam railway, and in the close vicinity or stations, and such locations are not desirable for residence, but the tramway, running along the street or highway, and stopping upon signal, is most convenient. The speed may not be so great, but it need not be, since the total time required for the journey from door to door may still be less. Apart from the time required in the actual journey there must be considered the time consumed in meeting certain trains, this almost invariably demanding a disturbance in the immediate affairs of the day, lest the connection be missed. With the tramway the passenger boards the car when he is ready, and does so at some convenient point of departure, and is put down at or very near his destination, and this is exactly what he wants. With the steam railway, he must catch a train, purchase a ticket, and be delivered at a station, from which he finds his way homeward as best he may. The actual distance covered by the ride may be passed over more quickly by the steam road, and yet he may waste less time between actual terminals with the tramway. For long distances the steam railway is at present the superior; for short rides the electric tramway is far better; between the two there is a space where they overlap.

It is the handling of the traffic in this debatable distance of overlapping upon which the skill of management appears. The fundamental principle determining the critical point in the division of traffic is the total time consumed in taking the passenger from his house to his office, or between equivalent points. A very common mistake is the assumption that all the passengers must properly be brought to some general distributing point in a given city. This leads to a congestion of traffic and a limitation of usefulness, which might be largely avoided by arranging a number of termini, about equally distant from the dense centre of business and readily reached in a few minutes. The crowds would thus begin to be dispersed from the start, and good speed could be immediately established.

"The suburban steam roads get passengers who properly belong to the street railways, just in proportion to the amount of annoying congestion which the latter systems encounter. Anything which decreases this congestion means an added advantage over the only rival whom the street railway man now has to meet, and we believe that while improvements in motive power and increase of speed have done much to better the traffic conditions on large street railway systems, that there is still general room for improvement in the arrangement of schedules and of routes with reference to the distribution of the passengers."

The above considerations bear directly upon the present relations of steam and electric roads for suburban traffic, but it cannot be assumed that these relations are to remain permanent. The speed of electric cars will be increased just in proportion to the possibilities of the traffic, and the business side of the question will continue to depend upon the manner in which the service satisfies the wants of the passenger. If the electric road carries him more quickly, more cheaply, and as comfortably, between the points of his travel, he will undoubtedly use it to the abandonment of other systems. The distance over which the electric road can do this will doubtless continue to increase, and it is altogether possible that the limit will be the hours of daylight, and that through steam traffic may ultimately be relegated to long-distance journeys, involving night travel. Even here the tractive power may, and probably will be electricity, but that feature of the question is foreign to the present discussion. Certain it is, however, that suburban traffic belongs to the service which is most acceptable to the passengers, and past methods must give way to present ones, regardless of the opinions of those whose individual interests may be affected.

Power Distribution from Central Stations.

IN a recent paper presented before the electrical section of the Franklin Institute, and published in the *Journal* of the institute, Mr. Charles F. Scott reviews the present state of the generation of electrical stations for power distribution in an interesting manner.

Leaving the question of the actual power generation in the steam portion of the plant for the present out of consideration, as well as the features involved in the determination of the size of units, location of sub-stations, and arrangement of distributing conductors, Mr. Scott devotes himself to the conversion of the mechanical into electrical energy, comparing the present practice with which obtained a few years ago.

"During the past few years central station engineers have been encountering new problems which have, in a measure, brought to life the old controversy between the direct current and the alternating current, although in a different form. The magnitude of electrical work, the areas which must now be covered, the economies which are necessary in the generation of current and its distribution, bring new requirements. The wilderness of shafting, pulleys, belts and high-speed machines which did service some years ago has given place to stations with large direct-connected units; but even these are now becoming inadequate in stations for the generation of direct current for several reasons. The limited area over which current at low voltage can be distributed without undue cost for conductors makes it necessary to place the station at the centre of the district to be supplied, and if this area exceeds a few square miles, it is necessary to erect additional stations. The supply of current to a large area therefore comes from a number of stations, and the economies of a large generating plant are not secured. Moreover, as these central stations should be located near the centres of their respective areas, they will usually be found in districts where real estate is expensive and where there is not the advantage of cheap transportation of coal and ashes which might be secured if the location of the station were selected with respect to its own specific function of generating current cheaply, and not on account of the necessities of the distributing system."

It is these limiting conditions which have compelled the return to the alternating high-voltage system for current distribution, generally in connection with the use of the transformer and converter for the modification of the current before actual application. The alternator of to-day, however, is a very different machine from that of ten or twelve years ago. Direct connected machines are the rule.

"Belt and pulley have been discarded and the engine supplies the shaft and bearings. In many large machines the revolving armature has given place to a revolving field, which is constructed to have mechanical safety comparable with that of a fly-wheel, and in fact to perform the mechanical functions of a fly-wheel, thereby placing the fly-wheel exactly where it is required, without the strains which would otherwise come upon an intervening shaft. The stationary armature winding is laid in grooves or slots; it is not the hand winding of the olden time, but a succession of coils wound to exact dimensions on a lathe and insulated before being put in place, or else a succession of straight bars which can be shoved endwise into partially closed slots and joined at the ends by connectors of copper strap."

Mr. Scott goes into the question of parallel running at some length, showing the mechanical analogy to the engines geared to the same driving shaft, a certain degree of flexibility being provided by the assumption of flexible arms to the gear wheels. A similar analogy might be found in the connecting of more than one engine in connection with cable traction driving, including the use of the "jack-in-the-box" system of gearing to equalize the power.

The rotary converter comes in for a large share of attention, permitting, as it does, the economical conversion of high-pressure alternating currents into continuous currents of any desired pressure, suitable for use in street-railway or other motors. The use of induction motors is also considered, and their applicability to many purposes shown.

Regarding the central station of the future, Mr .Scott shows how the combinations of capital which tend to the concentration of the power and electric interests of a city into a single system; the development of electrical apparatus to meet the requirements of such a system; the prospect for cheapening of power; the development of the various means by which power may be utilized, are all factors which indicate that it is the central station of the future, from which is to come the energy upon which industrial life and social activity and advancing civilization depend.

Engineering in the Nineteenth Century.

In the course of a series of reviews covering the material progress of the nineteenth century and published in the *New York Sun*, there is included one on civil engineering written by Mr. Thomas Curtis Clarke, Past President of the American Society of Civil Engineers, and well known on both sides of the Atlantic as an engineer of wide experience and ability.

Mr. Clarke takes the position that the material prosperity of the last century was mainly due to three classes of men, the man of pure science, devoted to the discovery of the laws of nature; the inventor, eager to apply those laws to money-making purposes; and the engineer, making a scientific application of the laws of nature by means of his knowledge of physical conditions.

Taking up the last department of the work, he divides the subject into statical and dynamical engineering, these being really more precise names for what are more commonly known as civil and mechanical engineering, the latter including electrical engineering, and all being included in the still broader title of industrial engineering, the production of articles useful to man.

Briefly running over the subdivisions selected by Mr. Clarke, we note structural enginering, railways, bridge building, foundations, hydraulics, power generation, metallurgy, and chemical technology. Of these but a few can be touched upon here, and that only to prepare for the general conclusions which follow. Of all these branches, only structural engineering, bridge building, and the necessary foundations had any material place before the beginning of the nineteenth century. Power generation, with the exception of water power, and that on a very limited scale, began with the utilization of coal, and Watt's invention, although dating from 1769, did not really begin to influence the world until the beginning of the last century; while railroading followed it nearly fifty years later.

With the development of railways came the corresponding advance in bridge-building with iron and steel, until we now have viaducts more than 300 feet high, and bridges with spans of 1,600 feet.

The older foundations were massive and secure, but slow and costly of construction. To-day we have the pneumatic process, sinking iron caissons, without disturbing the surrounding soil, and reaching rock through many feet of sand or earth.

In some forms hydraulic engineering is a very old branch of the art, but in others great advances have been made. Canals are now constructed of great size and with much rapidity, solely by reason of the use of improved machinery, while purification processes enable drinking water supplies to be had from sources otherwise entirely unsafe. One of the oldest sources of water supply for irrigation, the Nile, is soon to be regulated by the construction of the great dams at Assouan and Assiut, so that uncertainty will no longer exist as to the fertility of the seasons in Egypt.

But it is in mechanical engineering, properly so-called, that the greatest advances have been made. Not only in the generation and transmission of power, but also in its innumerable applications, the mechanical engineer has done far more in the nineteenth century than others had done in all the centuries which preceded it. The whole tendency of the work of the mechanical engineer has been to remove from man the necessity for physical effort, reserving for him the direction and control of forces generated for his use from the stored energy of nature. With this has come the greatly extended application of the principle of the duplication of pieces, so that articles of which the cost would be prohibitory if made singly, can be produced at a trifling cost by the thousand.

The winning of metals from the earth has advanced to such an extent that mines formerly abandoned have since well repaid the re-working, while iron and steel have become so vastly cheapened in cost as to be applicable for uses formerly out of the question. With these developments the art of steam navigation has developed to an extent which has produced floating power houses with the population of cities and the speed of railway trains.

In his conclusion Mr. Clarke pertinently asks why all this material development was delayed so late. He finds the answer to this question in the fact that in earlier ages the reign of law was not fully extended, securing to men the product of their labors, nor was there that union of scientists, inventors, and engineers, so necessary to the full development of all their work.

To-day all secrecy is disappearing, and all must work in the full light of day, while technical journalism, and the classification, indexing, and systematization of knowledge unite to enable every one to benefit by the work of all others.

"Combination, organization and scientific discovery, inventive ability, and engineering skill are now united.

"It may be said that we have gathered together all the inventions of the nineteenth century and called them works of engineering. This is not so. Engineering covers much more than invention. It includes all works of sufficient size and intricacy to require men trained in the knowledge of the physical conditions which govern the mechanical application of the laws of nature. First comes scientific discovery, then invention, and lastly engineering. Faraday and Henry discovered the electrical laws which led to the invention of the dynamo, which was perfected by many minds. Engineering built such works as those at Niagara Falls to make it useful.

"An ignorant man may invent a safety pin, but he cannot build the Brooklyn Bridge.

The engineer-in-chief commands an army of experts, as without specialization little can be done. His is the comprehensive design, for which he alone is responsible. Such is the evolution of engineering, which began as a craft and has ended as a profession.

"In past times, civilization depended upon military engineering. Warriors at first used only the weapons of the hand. Then came military engineering, applied both to attack and defence, and culminating in the invention of gunpowder. The civilization of to-day depends greatly upon civil engineering, as we have tried to show. It has changed the face of the world and brought all men nearer together. It has improved the condition of man by sanitary appliances and lowering the cost of food. It has shown that through machinery the workman is better educated, and his wages are increased, while the profits of capital increase also. It has made representative government possible over vast areas of territory, and is democratizing the world.

"Thoughtful persons have asked, will this new civilization last, or will it go the way of its predecessors? Surely the answer is: All depends on good government, on the stability of law, order, and justice, protecting the rights of all classes. It will continue to grow with the growth of good government, prosper with its prosperity, and perish with its decay."

Locomotive Building in the United States.

In connection with the question of the development of American locomotive building, and the extent to which American locomotives have entered the markets of the world, some comments upon a statement, by Mr. John H. Converse, in a recent issue of the *Iron Age*, are appropriate.

Speaking as a member of the largest locomotive-building firm in the United States, Mr. Converse says that in his opinion there have been three reasons for the introduction of American locomotives into Europe and the colonies:

"First, the possibility of much earlier deliveries than any European works could make. Our large capacity and facilities have made it possible to fill a large order in a very short time. Second, to some extent the preference for American locomotives as to their type and size and details. And, third, the question of price. Owing to the design and character of American locomotives they can be and have been constructed at a less cost per unit of weight than the ordinary European locomotives, although the wages paid are considerably higher than the wages in European locomotive works. There are two reasons for that. In the first place, the character of American workmen, their disposition to be industrious and their intelligence in their work; and, second, the much larger use of machine tools and improved machinery in this country than abroad. The fact that we have a very large home market strengthens us for going abroad and seeking business."

The development of the American locomotive to meet the demands of the rapidly growing American service, both as to speed in express service and hauling capacity for freight trains, is emphasized by Mr. Converse. To-day there are trains running in the United States scheduled at speeds between 70 and 80 miles an hour. The introduction of heavier steel rails, and the strengthening of bridges and viaducts have both made possible heavier locomotives and cars.

"We have probably more than doubled the weight of locomotives in 25 or 30 years, and at the same time have made most important improvements in the quality of material, but have done it with an increase in the price of not more than 40 or 50 per cent. The changes in the material have been the adoption of steel for boilers instead of iron; of thicker boilers and stronger boilers, made in a much more expensive and elaborate way, so as to be capable of carrying a steam pressure of 200 pounds to the square inch, whereas 30 or 40 years ago 100 pounds was the ordinary pressure. More parts are made of steel about the locomotive than formerly; tender frames are made of steel; the tanks are made of steel; the cabs are made of steel, where they were formerly of wood. All the wheels under a locomotive and tender are steel tired, where formerly both the tender and engine wheels were cast iron. This substitution has been made possible by great improvements in the production of steel. These changes are common to all locomotive works in America, but in Europe they have not been forced to make the changes which we have in this country. Their practice has been more firmly established there, and they have adhered to their original standards to a greater extent than we have. Our American railroad system was built up largely on borrowed money and had to be developed under conditions of the greatest economy; light rails, wooden bridges, cheap structures, cheap locomotives and cars had to be used in order to make it possible to stretch the railroads that we have stretched across our western territories; but with the growth of the country and the strengthening of these great railroad lines the roads have been rebuilt, and heavier rails and better bridges and better equipment have been substituted. The locomotive and car manufacturers simply reflect the development of the country, of its interests, and have adapted themselves to that development."

The introduction of American locomotives in some countries has been against very high tariffs, as for example in Russia, where the duty of four cents a pound is ample to protect Russian makers. For the Siberian railway, however, this did not enter, as the contracts provided for delivery on board steamer at a Russian port.

The principal difference between American and European locomotives is the use in America of the bar frame, contrasted with the plate frame. Outside cylinders are invariably used in America while in Europe inside cylinders and cranked axles are the rule, although many of the four-cylinder compound engines have both outside and inside cylinders. At the present time it appears as if the limit of weight for roadbed and bridges had been attained in the 100 ton locomotives, and that the maximum economy in hauling had been reached, but it is possible that even this present limit may be surpassed.

It is evident that in locomotive building, as in other things, it is the survival of the fittest which must be expected. The fittest, however, it not the same for all parts of the world. American conditions approach more nearly those of colonial and Russian service, than do those in England and central Europe, and hence it is not surprising that the American engines find their way to what may be termed their own locality. With the general unification of permanent way, including grades, curves, weight of rails, loading gauge, etc., there will probably be evolved an international type or types of locomotives, uniting all the best features of practice all over the world, and the local peculiarities will be merged in the general combination.

Deep Building Foundations.

THE modern tall building is also in many cases a deep building, for in but few instances is sufficiently solid foundation found near the surface. It is also in nearly every case desirable to provide space beneath ground for boilers, engines, dynamos, etc., and so cellars and sub-cellars are needed.

An interesting account of the construction of the deep foundation of a tall building in New York is found in a paper by Mr. T. Kennard Thomson in a recent issue of *Engineering News;* the structure under consideration being the new building for the Mutual Life Insurance Company. This description includes not only the sinking of the caissons to bed rock, but also the underpinning of the surrounding buildings, and as the site is in the midst of the tall building district, this latter became a much more serious problem than is usually the case.

Mr. Thomson's paper, which is very complete, is mainly a continuous narrative of the conduct of the work, including the manner in which the various obstacles were overcome, and for all details the original must be consulted. The principal features to be noted are the methods by which foundations carrying 20 to 70 tons per square foot of base were underpinned and permanently transferred to cylinders sunk for the purpose. Among these were the foundations of one wall of the Stokes Building, an

18 story office building, containing on the ground floor the vaults and safes of a safe-deposit company, the locks of which would be thrown out of gear by a very slight settlement.

The cylinders were first carried down through quicksand to hard pan, but when it was found that there was sand beneath this, it was considered best to go all the way down to the rock.

The work involved the use of many bold expedients for permitting the conduct of the foundation construction within a limited area, surrounded by high buildings in constant use, and the manner in which the new supports were placed under the existing walls, and the cellar for the new building excavated to a point 35 feet below the surrounding water level, all reflect great credit upon the engineers. As an instance of the bold application of engineering to building construction, this may well be considered an example of American ingenuity in overcoming difficulties, and the paper will doubtless be studied with much interest by constructing engineers in England as well as America.

Reinforced Concrete in America.

The development of reinforced concrete in Europe has been discussed among the reviews of the Continental press, elsewhere in this issue, and as a fitting complement to the opinions of Herr von Emperger we may call attention to the symposium before the Boston Society of Civil Engineers, published in a recent issue of the *Journal of the Association of Engineering Societies.* Papers were contributed by a number of members, these relating mainly to the use of combinations of concrete and metal for floors and floor arches, as well as for fireproof construction.

In the United States, with some exceptions such as the Topeka bridge, and a few others, the use of reinforced concrete has mainly been as an auxiliary to metal construction, both for fireproofing, and as a convenient and satisfactory medium for the construction of walls, floors, and partitions. Its advantages for these purposes are now so generally admitted that it may soon become the standard method for floor construction in steel-frame buildings, taking the place of brick or tile arches. The question of rust appears to be no longer considered, and when the metal is properly imbedded in Portland cement concrete or plaster there need be no fear of weakening by rust, the metal being far better protected from dampness than when encased in tiles, brick, or other sheathing which permits the access of damp air. In this connection another advantage of concrete-metal construction for bridge and similar work appears, in that there is no need for the application of frequent coats of paint or other protection, since the structure, when completed is practically a monolith, and as permanent and enduring as if built of masonry.

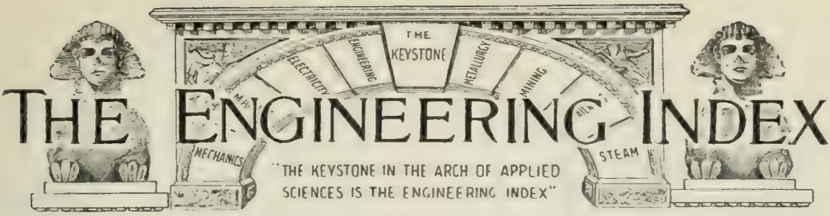
An allied application is the use of concrete sheathing for the protection of wooden piles from the attacks of the teredo navalis, a pipe being constructed about the pile after it has been driven to position. The cost is estimated as greater than that of coppering, and the durability of the combination has not yet been fully established. It has been stated that an electrolytic action may occur, due to the influence of the sea water, and this question can only be definitely settled by longer experience than has yet been possible.

Another use for reinforced construction, and one which has also been extensively employed in France, is for the building of water-conduits, and sewers. For such work expanded metal is especially applicable, and tests which have been made with experimental arches of this combination have been most satisfactory. The facility with which a conduit can be constructed in the trench is an especial advantage of the combination for such work, and it will doubtless have a wide application.

The various papers contain a great mass of detail and practical data concerning various systems, and it is remarkable to note how extensively the whole construction has developed with the few years which it has been before the public.

The opinion of such an authority as Mr. George S. Morison may well be quoted in this connection:

"I fully believe that we are now only at the beginning of concrete construction, and that, if the results which we hope for can be attained, with concrete structures with metal structures inside, the time will come when this will be the only method of building."



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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Arch.

Circular Arches Fixed at the Springings (Sur les Voûtes en Arc de Cercle Encastrées aux Naissances). M. Ribière. A mathematical analysis, deriving formulas based upon the elastic theory. 1000 w. Comptes Rendus—Feb. 11, 1901. No. 39916 D.

Bridge Building.

European and American Bridge Building Practice. T. C. Clarke. A comparison of methods showing the economy which has been effected by the extended use of machinery and standardisation, enabling American works to compete successfully for European and Colonial work. 3000 w. Engineering Magazine—April, 1901. No. 39965 B.

Caisson.

The Brooklyn Caisson for the Manhattan-Brooklyn Bridge. Illustrated description of a heavy timber pneumatic caisson 144 x 78 ft. in plan to carry one pier of a suspension bridge of 1,400 ft. clear span. 1900 w. Eng Rec—March 2, 1901. No. 39630.

Cantilever.

The Switchback Arch Bridge of the White Pass and Yukon Railway. Illustrated description of this interesting structure and its erection and tests. 1400 w. Eng News—March 28, 1901. No. 40050.

The "Switchback" Cantilever Bridge, White Pass & Yukon Ry. Illustration and description, stating the natural difficulties of the locality. 900 w. Ry & Engng Rev —March 16, 1901. No. 39895.

Design.

Aesthetics in Bridge Building. Remarks on the work of various nations, suggested by a paper read before the British Inst. of Civ. Engs. 1800 w. Arch, Lond—March 15, 1901. No. 40041 A.

The Aesthetic Treatment of Bridges. Review of a paper read by an engineer, Mr. Husband, before the British Inst. of Civ. Engs. 2000 w. Builder—March 15, 1901. No. 40042 A.

Drawbridge.

Floating a Drawbridge into Place. An illustrated account of the work of substituting a new and heavier drawbridge for an old one across the Hackensack River, on the Morris & Essex Div. of the D., L. & W. R. R. 2400 w. Ir Age—March 7, 1901. No. 39618.

Moving the Hackensack River Drawbridge. Illustrated description of the method of floating two large draw spans, one replacing the other. 2100 w. Eng. Rec.—March 9, 1901. No. 39696.

Two Drawbridges on the New York Central Railroad. An illustrated account of two steel drawbridges to be built, of interest because of the conditions to be met at the sites. 1500 w. R R Gaz—March 15, 1901. No. 39796.

Ferry.

The Overhead Ferry at Rouen. Reviews the usual methods of crossing channels, and describes the system of a car suspended from a high level bridge as used at Rouen, stating its advantages. Ill. 2000 w. Cons Repts, No. 996—March 28, 1901. No. 40062 D.

Foundations.

Some Odd Jobs of Foundation Work. W. A. Rogers. Describes a few problems in masonry and foundation work, of a perplexing nature, which have been solved during the last season by the Bridge and Building Department of one of the large railroads. 3300 w. R R Gaz —March 8, 1901. No. 39745.

Girders.

A Direct Method of Spacing Rivets and Finding the Position, Etc., of Stiffeners in Plate Girders. Continued discussion of paper by E. Schmidtt. 4500 w. Pro Am Soc of Civ Engs—Feb., 1901. No. 39583 E.

India.

Bridges of India. An illustration and brief description of the Jubilee (Hooghli) Bridge, East Indian Railway, is given in the present article. 700 w. Ind & East Engr—Feb., 1901. Serial. 1st part. No. 39813 D.

Kinzua Viaduct.

The Kinzua Viaduct of the Erie Railroad Company. Continued discussion of paper by C. R. Grimm. 6500 w. Pro Am Soc of Civ Engs—Feb., 1901. No. 39582 E.

Masonry.

Masonry. Report of the Com. of the Am. Ry. Engng. & Main. of Way Assn. Classifies the different kinds of masonry, discussing the materials, economic considerations, and designs. Also discussion. 15500 w. Ry Age (Spe. No.)—March 15, 1901. No. 39887 D.

New York.

Brooklyn Tower Foundation, Third East River Bridge. An illustrated description of the caisson and cofferdam work and the masonry work. 2800 w. Eng News—March 7, 1901. No. 39673.

East River Bridge No. 3. Gives a map showing the location of the three bridges, with illustration and particulars concerning "No. 3," for which bids are now called. 900 w. R R Gaz—March 1, 1901. No. 39556.

Erection of Upper Parts of Towers of New East River Bridge, New York. Illustrated description of contractors' methods of constructing unusually lofty and heavy towers. 2000 w. Eng Rec—March 30, 1901. No. 40071.

The Fourth East River Bridge, New York. Description of cantilever structure 8,231 ft. long between Manhattan and Queens. 800 w. Eng Rec—March 16, 1901. No. 39820.

Reconstruction.

The Reconstruction of the Glasgow Bridge on the Chicago and Alton Railway. W. D. Taylor. Illustrated description of a railway bridge, 2,805 ft. long, over the Missouri River, with notes on special methods of erecting long spans and unusual details of steel work. 5000 w. Eng Rec—March 16, 1901. No. 39819.

Reinforced Concrete.

A Submerged Bridge. A discussion of the unique features of a concrete-steel bridge designed to be submerged 20 ft. at times in a swift current. 1000 w. Eng Rec—March 9, 1901. No. 39695.

The X Bridge at Mans, France. Illustrated description of a reinforced concrete structure having very light single columns with expansion rollers, on which rest plate-girder spans. 1100 w. Eng Rec—March 23, 1901. No. 39876.

See Civil Engineering, Construction.

Standard Plans.

Northern Pacific Standard Bridge Plans. Ralph Modjeski. An explanation of the new standards prepared by the writer, with critical discussion, and writer's conclusions. Also a diagram of weights, and plates. 6400 w. Jour W Soc of Engs—Feb., 1901. No. 39765 D.

Swing Bridge.

An English Floating Swing Bridge. Describes a swing span 112 ft. long, supported on a circular steel pontoon, made necessary on account of the rapid settlement of loaded ground due to the pumping of brine from below the surface. 1000 w. Eng Rec—March 23, 1901. No. 39-879.

Sydney.

The Awards in the Sydney Bridge Competition. Brief description of leading designs for a very long bridge across Sydney Harbor, N. S. W., with diagram of cantilever design awarded first prize. 1200 w. Eng Rec—March 2, 1901. No. 39632.

Trestles.

Bridges and Trestles. Report of the Com. of the Am. Ry. Engng. & Main. of Way Assn. The subject was divided and assigned to seven sub-committees, whose various reports are submitted and discussed. Ill. 22000 w. Ry Age (Spe. No.)—March 15, 1901. No. 39889 D.

A New Subaqueous Viaduct. Fred W. Lepper. Illustrates and describes the engineering features of a proposed submarine viaduct. 1700 w. Eng News—March 28, 1901. No. 40056.

Viaducts.

The Gokteik Viaduct: Burmah Railways, Ltd., Burmah. Brief illustrated description of one of the most notable bridge structures erected by American bridge-builders in foreign countries. It is 2260 ft. long, and 320 ft. high, and required 4,852 tons of steel work for its construction. 1200 w. Eng News—Feb. 28, 1901. No. 39569.

Viaduct and Tunnel Construction on the North Bohemian Railway. (Die Viaduct und Tunnelbauten der Nordböhmischen Transversalbahn). H. Rosche. With details of the construction of large masonry viaducts and of the timbering of tunnels. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—March 1, 1901. No. 39928 B.

Viaduct at Jackson, Minn., C. M. & St. P. Ry. Illustrations and brief description of a steel trestle bridge with plate-girder deck spans, carrying a single track. 500 w. Ry & Engng Rev—March 2, 1901. No. 39626.

CONSTRUCTION.

Excavation.

Drilling and Blasting. Submerged Rock. A statement of the cost and methods of drilling and dredging 11,000 yds. of rock in 4 to 8 ft. of water. 1500 w. Eng Rec—March 9, 1901. No. 39697.

Sections 6 A and 6 B, New York Rapid Transit Railway. Illustrated description of the method of trenching in a crowded street without materially interfering with street railway traffic or wagons. 1800 w. Eng Rec—March 30, 1901. No. 40070.

Foundations.

The Foundations of the New Mutual Life Insurance Building, New York City. T. Kennard Thompson. Illustrated detailed description of one of the most notable tall building foundations ever constructed. 8500 w. Eng News—March 28, 1901. No. 40052.

Reinforced Concrete.

Recent Structures in Concrete and Iron (Neuere Bauweisen und Bauwerke aus Beton und Eisen). F. von Emperger. A fully illustrated description of the later combinations of iron and concrete construction with special reference to the buildings at the Paris Exposition. Two articles. 7500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver. Feb. 15, 22, 1901. No. 39927 each B.

See Civil Engineering, Bridges.

Roads.

Oiled Road Construction in San Bernardino County, Cal. Describes a method of constructing a road from gravel and sand sprinkled with heavy oil and rolled much like macadam. 1200 w. Eng Rec—March 30, 1901. No. 40072.

Road Building and Other Public Works in Porto Rico Under the U. S. Military Administration. Illustrated article showing the extent and character of the work, abstracted from the reports of Capt. William Judson. 2000 w. Eng News—March 21, 1901. No. 39855.

The New Specifications for Broken Stone Roads in New Jersey. A review of the requirements adopted by the Association of State and County Road Engineers of New Jersey. 1200 w. Eng Rec—March 30, 1901. No. 40077.

Skeleton Construction.

Modern Construction at the Court Theatre, Vienna. Edwin O. Sachs. Drawings and discussion of features of constructional iron-work. 1700 w. Engng—Feb. 22, 1901. Serial. 1st part. No. 39603 A.

Strains.

Some Principles Common to All Building Materials. Frank Caws. A comparison of the strength and strains of building material with the human body. 6500 w. Jour Reg. Inst of Brit Archts—Feb. 9, 1901. No. 39661 C.

Tunneling.

Tunneling with a Roof Shield at East Boston. Illustrated description of the method of driving a double-track tunnel by means of advance headings on each side for the walls, with a roof shield run forward afterward on top of these walls. 900 w. Eng Rec—March 23, 1901. No. 39873.

Tunnel and Crib Construction in Chicago. Paul G. Brown. An illustrated review of the construction work, giving information concerning cost, methods, improvements, etc., in both lake and land tunnels. 7200 w. Jour W Soc of Engs—Feb., 1901. No. 39763 D.

CANALS, RIVERS AND HARBORS.

Dams.

Failure of Bulkhead at Dyer Dam, Danielson, Conn. Ernest H. Brownell. Describes the accident and explains its probable cause. Ill. 800 w. Eng News—March 28, 1901. No. 40054.

The Failure of Two Earth Dams at Providence, R. I. Ernest H. Brownell. An illustrated account of a recent disaster. 1300 w. Eng News—March 21, 1901. No. 39858.

Docks.

A New Dry-Dock at Baltimore. Illustrated description of a large timber dry-dock with concrete abutments constructed on a very unfavorable site. 1300 w. Eng Rec—March 16, 1901. No. 39822.

New C. M. & St. P. Ore Dock at Escanaba, Mich. Illustrated description of a recently completed dock of great capacity and modern design. 1500 w. Ry & Engng Rev—March 16, 1901. No. 39896.

New Dock and Harbor Works in the East of Scotland. An account of improvements at Grangemouth, Leith and Burntisland. Ill. 3000 w. Engr, Lond—March 8, 1901. No. 39807 A.

The Portsmouth Dry-Dock. Illustrated description of the method of excavating rock for a 750 x 130 ft. masonry dock, where the site was spanned by special truss conveyors delivering the spoil from the pit in either side of the site. 2800 w. Eng Rec—March 23, 1901. No. 39872.

Drainage Canal.

Design for a Controlling Works at the Chicago End of the Drainage Canal. Ossian Guthrie. Describes plan for the purpose of maintaining a uniform current for the relief and navigation of vessels. General discussion. 3800 w. Jour W Soc of Engs—Feb., 1901. No. 39764 D.

The Improvement of the Chicago River. Addresses at the annual dinner of the W. Soc. of Engs. by R. W. Hunt, L. E. Cooley, P. B. Weare, O. N. Carter, A. R. Reynolds, J. C. Braden, Wm. H. Chadwick, Isham Randolph, Wm. Boldenweck, and J. G. Keith. 11500 w. Jour W Soc of Engs—Feb., 1901. No. 39762 D.

Dredge.

A Large Single-Rope Dipper Dredge. Illustrates and describes a large dipper dredge recently put in service at Chicago, for river and harbor improvements. 1400 w. Eng News—Feb. 28, 1901. No. 39574.

Groynes.

Beard's Contour System of Groynes. Brief illustrated description of this system which is designed to take advantage of the action of the sea to build up a beach that will form a permanent natural protection. 1200 w. Engng—Feb. 22, 1901. No. 39608 A.

Isthmian Canal.

The Isthmian Canal from a Military Point of View. Col. Peter C. Hains. Extract from an address before the Am. Acad. of Political and Social Science. Considers a neutral canal, with a large area of neutral waters at each terminus a more useful canal to the United States than one controlled by military power. 700 w. Eng News—Feb. 28, 1901. No. 39573.

Lighthouse.

Metal Casing for a Light House Tower at Grande Pointe au Sable. Illustrated description of the sheet steel casing built about a brick shaft beginning to deteriorate. 1100 w. Eng Rec—March 2, 1901. No. 39634.

London.

The Port of London. W. H. Wheeler. Discusses the unsatisfactory conditions of this port and the causes. 4000 w. Engr, Lond—March 1, 1901. No. 39730 A.

Naples.

The Harbor of Naples (Le Port de Naples). C. de Cordemoy. With plan of the harbor and elevations and sections of the moles. 1800 w. Revue Technique—Feb. 25, 1901. No. 39908 D.

New York Canals.

Canals from the Lakes to New York. Continued discussion of papers by Messrs. Joseph Mayer and George Y. Wisner. 14000 w. Pro Am Soc of Civ Engs—Feb., 1901. No. 39581 E.

Surveys for a Barge Canal Across the State of New York. Abstract of the report of the survey presented to the Governor by the State Engineer, stating the important features. Also editorial discussion with extracts from the Governor's message. 4500 w. Eng News—March 21, 1901. No. 39856.

The Latest Report on the Improvement of the Erie Canal. A review of the recommendations of the State Engineer for a 1,000-ton barge canal, and of the Governor for a smaller waterway. 2200 w. Eng Rec—March 23, 1901. No. 39871.

Panama.

Recent Claims for the Panama Canal. A discussion of the influence of earthquakes, trade winds and curvature on the selection of a route across the isthmus. 1500 w. Eng Rec—March 30, 1901. No. 40068.

The Panama Canals. Editorial review of paper by J. T. Ford, read before the Inst. of Civ. Engs. (England), discussing the engineering lessons to be learned from the conditon of the Panama Canal works since their abandonment. 1300 w. Eng Rec—March 2, 1901. No. 39629.

Sault Ste. Marie.

Clergue's Great Enterprises. Review of what Francis H. Clergue and his associates have done at Sault Ste. Marie, and what they propose to do. 4000 w. Marine Rev—March 7, 1901. No. 39753.

MATERIALS.

Artificial Stone.

The Industry of Sandstone Bricks (L'Industrie de la Brique de Grès). H. de Graffigny. A review of the various processes in practical use for making artificial stone bricks of lime and sand. 2500 w. Revue Technique—Feb. 25, 1901. No. 39909 D.

Asphalt.

Alcatraz Asphalt. Notes concerning the elaborate methods for dissolving in naphtha and piping 30 miles asphalt obtained by boiling asphaltic sand. 600 w. Eng Rec—March 23, 1901. No. 39874.

The Asphalt Deposits of Venezuela. From the *N. Y. Times.* Map and description. 1000 w. Eng & Min Jour—March 9, 1901. No. 39752.

The Pitch Lake and the Asphalt Industry of Trinidad. An illustrated description of the deposit and method of excavating, transporting, etc. 1800 w. Sci Am—March 16, 1901. No. 39775.

Cement.

American Slag Cements. Abstract of paper by W. K. Hatt, giving results of tests of cement made by grinding a mixture of slag and lime. 1600 w. Eng Rec —March 2, 1901. No. 39631.

Cement Kilns.

A British Opinion of Rotary Current Kilns. An abstract of a paper by W. H. Stanger and B. Blount before the Inst. of Civ. Engs., approving American rotary kiln practice. 1000 w. Eng Rec—March 16, 1901. No. 39823.

Concrete.

Concrete Mixing and Depositing Machine. Illustrates and describes the concrete train for making and depositing concrete for retaining walls used on the Chicago & Western Indiana R. R. 1200 w. Eng News—Feb. 28, 1901. No. 39571.

Fireproofing.

A Discussion of Recent Developments in the Fire Proofing of Wood. Joseph L. Ferrell. Illustrated description of the methods, and tools used and a statement of the efficacy of the treatment. 4000 w. Jour Fr Inst—March, 1901. No. 39640 D.

Timber.

The Strength of Timber. Discusses tests made and quotes from records of investigations by the U. S. A. Dept. of Agriculture. 2700 w. Builder—March 2, 1901. No. 39718 A.

MEASUREMENT.

Spirit Leveling.

The Theory and Practice of Precise Spirit Leveling. David A. Molitor. Continued discussion of this paper. 9500 w. Pro Am Soc of Civ Engs—March, 1901. No. 40081 E.

Surveying.

A Simple and Convenient Instrument for Mine Surveys. Frank Robbins. Read before the Canadian Min. Inst. Illustrated description. 2500 w. Can Min Rev—Feb. 28, 1901. No. 39666 B.

The Adjustment of a Transit Survey as Compared with That of a Compass Survey. George W. Tuttle. Discussion of the paper by Charles L. Crandall. 2000 w. Pro Am Soc of Civ Engs—Feb., 1901. No. 39584 E.

The Adjustment of a Transit Survey as Compared with That of a Compass Survey. Continued discussion of a paper by C. L. Crandall. 2400 w. Pro Am Soc of Civ Engs—March, 1901. No. 40082 E.

MUNICIPAL.

Ancient Sanitation.

Sanitary Provisions in the Roman Colony at Lincoln, England. Abstract of a paper by Dr. William O'Neill, on the water and sewerage systems, crematory, and private baths. 1500 w. Eng Rec—March 23, 1901. No. 39880.

Chattanooga, Tenn.

Municipal Improvements at Chattanooga, Tenn. An account of improvements in the sewerage system, pavements, garbage disposal, etc. Ill. 2600 w. Eng News—March 7, 1901. No. 39671.

Garbage.

Garbage as Fuel for Steam Production. W. L. Hedenberg. States the success gained in England and urges a study of the subject in the United States as a matter of economy. 1000 w. Munic Engng—March, 1901. No. 39647 C.

Pavements.

Repairing Asphalt Pavements in Chattanooga. Robert Hooke. Describes methods used and gives illustration of a portable heater designed by the writer. 1700 w. Munic Engng—March, 1901. No. 39645 C.

Some Facts Relating to the Asphalt Paving Industry. P. W. Henry. Condensed from an address before the students of Rensselaer Polytechnic Inst. Reviews the development of this industry, especially in the United States, describing the foundation and the mixture, and the Pitch Lake of Trinidad and other deposits. 6400 w. Eng News—March 14, 1901. No. 39791.

Sewage Disposal.

A New Form of Septic Tank for Holland, Michigan. Messrs. Alvord & Shields. Illustrated description of a tank arranged to permit large variations in its capacity to suit the character of sewage to be treated. 1700 w. Eng Rec—March 16, 1901. No. 39821.

Recent Progress in Sewage Purification in England. Gilbert J. Fowler. Information concerning results of recent practice in England, and experimental work, with conclusions reached. 5000 w. Dom Engng—March 15, 1901. No. 37-846 C.

Sewage Disposal and Water Purification. John N. McClintock. Read before the Am. Soc. of Munic. Imp. Describes a septic tank system for sewage disposal, and explains its working, applying also the same principle to the purification of water. 4800 w. Dom Engng—March 15, 1901. No. 39847 C.

Sewage Disposal. A paper before the Indiana Engng Soc., by F. A. Barbour, on the utility of bacteriolytic processes of treatment and the degree of purification which it is advisable to strive for. 2900 w. Eng Rec—March 30, 1901. No. 40075.

The Connecticut Sewerage Commission on Methods of Sewage Disposal. A statement by a State Board on the merits and disadvantages of sewage disposal by chemical treatment, filtration, septic treatment, and biological filtration. 2500 w. Eng Rec—March 23, 1901. No. 39875.

Sewerage.

An Early Example of Combined Septic Treatment and Filtration of Sewage. Describes small installations in Italy made prior to 1890. 1200 w. Eng Rec—March 30, 1901. No. 40069.

Annual Reports of the State Sewerage Commissions of Connecticut and New Jersey. Describes the work of the commission in each State, and comments on the reports. 2700 w. Eng News—March 28, 1901. No. 40053.

Sewerage Systems of Industrial Works. An account of methods of construction found desirable in German works where the industrial wastes cause rapid deterioration of ordinary construction. 3800 w. Eng Rec—March 23, 1901. No. 39-878.

The Shelby, Ohio, Sewerage System. J. B. Weddell. Abstract of paper read before the Ohio Soc. of Surv. and Civ. Engs. Illustrated description of sewerage and sewage disposal works for 5,000 people. The sewage is received in tanks and passed through intermittent filters. 600 w. Eng Rec—March 9, 1901. No. 39698.

Streets.

The State of London Streets. Thomas Blashill. Read at meeting of the Sanitary Inst. Compares the streets of London with Continental cities and towns to their detriment, and discusses some details where improvements are needed. 2800 w. Builder—Feb. 23, 1901. No. 39592 A.

WATER SUPPLY.

Compressed Air Storage.

A Small Water-Works Plant at Trotwood, O., With Storage Under Compressed Air. Benjamin H. Flynn. Describes a small plant, in which the water is stored in a tank under an air pressure of 40 to 80 pounds. 600 w. Eng News—March 21, 1901. No. 39859.

Electrolysis.

Cause and Effect of Electrolytic Action Upon Underground Piping Systems. A. A. Kundson. Considers the cause of deflection of currents from well-bonded tracks to water mains; acute points of deflection; effect of joint resistance on water mains; effect upon water mains in a positive district. Ill. and discussion. 11200 w. Jour N. E. Water Wks Assn—March, 1901. No. 39638 F.

Electrical Current. F. A. W. Davis. A statement of the destructive action upon gas and water pipes, with illustrations. Also report of decisions of the U. S. courts in regard to difficulties arising from this cause. 3000 w. Jour N. E. Water Works Assn—March, 1901. No. 39636 F.

Factory Supply.

Water Supply Plant at the New Kensington Works of the Pittsburg Reduction Co. Edwin S. Fickes. Illustrated description of the plant and the difficulty experienced in sinking the suction well. 1100 w. Eng News—March 21, 1901. No. 39857.

Filters.

Covering Water Filters. A discussion, by Allen Hazen, of the condition under which it is advisable to cover sand filters. 4300 w. Eng Rec—March 23, 1901. No. 39877.

The Construction of Gravity Sand Filters at Nyack, N. Y. Discussion of paper by G. N. Houston. 3000 w. Pro Am Soc of Civ Engs—March, 1901. No. 40083 E.

The Sand Filters at Whitestown, N. Y. William G. Stone. Illustrated description of open sand filters with rather unusual arrangements of pipe for outlets and inlets. 1200 w. Eng Rec—March 30, 1901. No. 40074.

Filtration.

Filtration of Water for Public Use. Continued informal discussion on the above subject. 1600 w. Pro Am Soc of Civ Engs—March, 1901. No. 40084 E.

Gauge.

An Inexpensive Gauge for Use with the Venturi Meter. Charles P. Paulding. Explains briefly the theory of the Venturi tube, and gives illustrated description of the gauge devised by Henry Metcalfe for use with this water meter. 1200 w. Eng News—Feb. 28, 1901. No. 39570.

Ground Water.

Subterranean Waters. Charles Morris. Considers the conditions under which interior water exists, the service rendered by it, etc. General discussion follows. 4000 w. Jour Fr Inst—March, 1901. No. 39641 D.

Hotel Supply.

Plumbing in the Manhattan Hotel, New York. Illustrated description of the water supply system of a large New York hotel having a filter plant of 600 gallons' capacity per minute. 2000 w. Eng Rec—March 16, 1901. Serial. 1st part. No. 39827.

Irrigation.

An Unwatered Empire. Gen. Nelson A. Miles. On the importance of irrigation and the arid regions that could by this means be made productive. 1200 w. W Min Wld—Feb. 23, 1901. No. 39538.

Pumping Engine.

See Mechanical Engineering, Hydraulics.

Purification.

Experts' Report on Water Purification at Washington, D. C. Report of Messrs. Rudolph Hering, George W. Fuller, and Allen Hazen, to the Chairman of the U. S. Senate Committee. 2000 w. Eng News—Feb. 28, 1901. No. 39575.

Self-Purification of Polluted Water-Courses. Extracts from a report by Dr. Arthur R. Reynolds on experiments made on the waterway between Chicago and St. Louis. 4000 w. Eng Rec—March 16, 1901. No. 39824.

The Bacterial Self-Purification of Streams. Concerning the investigations conducted by Edwin Oakes Jordan, Ph. D., on the waters of the Illinois River and its tributaries, including observations at various points as far as the Mississippi. 1800 w. Sci Am Sup—March 2, 1901. No. 39544.

The Pollution and Self-Purification of Streams (Die Verunreinigung und Selbstreinigung der Flüsse). H. C. Nussbaum. An examination of the bacteriological conditions of rivers, with regard to their use for water supply; with data from various German rivers. 3000 w. Gesundheits-Ingenieur—March 15, 1901. No. 39940 B.

Water Mains.

Removal of Some Submerged Water Mains, at Chelsea, Mass. Caleb Mills Saville. Interesting description of the condition of a main laid in 1850, and of a siphon carrying water over the Mystic River. 2700 w. Eng News—Feb. 28, 1901. No. 39568.

Water Works.

A Model System of Water-Works. F. O. Jones. Illustrated description of a system suited for both domestic purposes and fire protection. 1600 w. Sci Am Sup—March 2, 1901. No. 39545.

The Pratt City Water-Works. Illustrated description of a small plant using an air lift for raising water from deep wells. 900 w. Eng Rec—March 30, 1901. No. 40073.

ELECTRICAL ENGINEERING

COMMUNICATION.

Arc.

The Speaking Electric Arc (Der Sprechende Elektrische Flammenbogen). E. Ruhmer. An examination of the vibrating electric arc as a receiver and transmitter; and its application to wireless telegraphy. 2000 w. Elektrotech Zeitschr—Feb. 28, 1901. No. 39951 B.

Cables.

High Tension Cables. E. Kilburn Scott. Discusses various kinds of insulation favoring the Brooks semi-solid system. 2500 w. Elec Rev, Lond—March 8, 1901. No. 39802 A.

Exchange.

A Notable Independent Telephone Exchange. George L. Burlingame. Illustrated description of the lamp signal branch exchange at East Cleveland, Ohio, of the Cuyahoga Telephone Company. 1900 w. Am Elect'n—March, 1901. No. 39682.

Long Distance.

The Long Distance Telegraph and Telephone Systems of Pupin, Thompson and Reed. E. F. Roeber. Considers these three methods, developing a mathematical theory of the Thompson system and the Reed system, following the analytical method used by Dr. Pupin. 2700 w. Elec Wld & Engr—March 16, 1901. Serial. 1st part. No. 39840.

Transatlantic Communication by Means of the Telephone. M. I. Pupin. An exposition by Dr. Pupin, of the improvements made by him in long-distance telephone lines, by which transatlantic telephony may become practicable. 4000 w. Engineering Magazine—April, 1901. No. 39969 B.

Wave Transmission Over Non-Uniform Cables and Long Distance Air Lines. M. I. Pupin. Discussion of the above named paper. 2700 w. Trans Am Inst of Elec Engs—Feb., 1901. No. 40002 D.

Microphone.

Berliner Microphone Patent Declared Invalid. States the claims of the patent and the substance of the recent decision at Boston by Judge Brown who decides that Berliner was antedated by both Bell and Edison. 2500 w. Elec Wld & Engr—March 2, 1901. No. 39623.

Berliner Telephone Patent Declared Invalid. Full text of decision as handed down at Boston, deciding the invention antedated by both Bell and Edison. 5000 w. Elec Rev, N. Y.—March 2, 1901. No. 39651.

Comment on the Berliner Patent Decision. A view of the telephone situation in the United States, giving interviews and opinions of prominent men, and the Berliner patent in full. Also editorial. 5500 w. Elec Rev, N. Y.—March 9, 1901. No. 39717.

Multiplex.

Multiplex Wireless Telegraphy with Tuned Apparatus. Discusses Prof. Slaby's experiments for using wireless telegraphy without interference of messages, and the solution of the problem; also the work of others in this field. 2300 w. Elec Rev, Lond—March 15, 1901. Serial. 1st part. No. 40022 A.

Space Telegraphy.

Present Condition of Wireless Telegraphy. Data received from Emile Guarini regarding wireless telegraphy; the system at present most popular; various systems in different lands; describing that employed by Mr. Guarini. 3300 w. U. S. Cons Repts, No. 977—March 6, 1901. No. 39772 D.

The Slaby Systems of Wave-Selective Wireless Duplex Telegraphy. Illustrates and describes this system which has proved successful, and explains the method of transmitting and receiving messages without interference with other stations. Also editorial. 2000 w. Sci Am—March 9, 1901. No. 39686.

Wireless Telegraphy. Dr. F. Braun. Substance of lectures delivered before the Strassburg scientific societies on experiments in this field. 1800 w. Elect'n, Lond—March 15, 1901. No. 40046 A.

Telegraphs.

The Burry Page-Printing Telegraph. Illustrated description of this very successful invention. A large number of the machines may be operated at the same time by a single sender at a central station. 2300 w. Sci Am—March 23, 1901. No. 39851.

Telephony.

The Arrangement of Several Telephones Upon the Same Circuit (Montage de Plusieurs Postes Téléphoniques sur un Meme Circuit). Em. Piérard. A comparison of the arrangements in series and in derivation. 1200 w. Electricien—March 2, 1901. No. 39934 B.

The Invention of the Telephone. George S. Davis. Gives the claims of William A. Skenkle to the invention. Also editorial. Ill. 3800 w. Elec Wld & Engr—March 23, 1901. No. 40010.

Telephonograph.

The Poulsen Telephonograph (Ueber den Telephonographen von Poulsen). Jul. H. West. A paper read before the Electrotechnical Society, illustrating and describing very fully the adaptation of the phonograph for recording telephonic communications. 4000 w. Elektrotech Zeitschr—Feb. 21, 1901. No. 39947 B.

Transmitter.

A Practical Transmitter Using the Line Wave for Cable Telegraphy; and Measurements with Alternating Currents Upon an Atlantic Cable. Albert C. Crehore and George O. Squier. Discussion of the above paper. 6800 w. Trans Am Inst of Elec Engs—Feb., 1901. No. 40001 D.

DISTRIBUTION.

Cables.

Insulation on Cables. Mervyn O'Gorman. Abstract of a paper read before the Inst. of Elec. Engs. (Eng.), with editorial. On the manufacture of cables, and their design. 7000 w. Elect'n, Lond—March 15, 1901. No. 40047 A.

Current Densities.

The Economical Current Density for Small Conductors. James Whitcher. The present article is an argument favoring the use of Lord Kelvin's law in the design of electric wiring systems, to be followed by a discussion of its practical application. 1500 w. Elec Rev, Lond—March 1, 1901. Serial. 1st part. No. 39693 A.

Switchboards.

The Niagara Falls Power Company's Switchboards. Arthur B. Weeks. Illustrated description of recent developments and improvements; feeder stands, emergency switches, etc. 1300 w. Elec Rev, N. Y.—March 2, 1901. No. 39650.

ELECTRO-CHEMISTRY.

Accumulators.

Acids for Filling Electric Accumulators. Rudolf Heinz. Translated from *Centralbatt für Accumulatoren und Elementenkunde.* On the importance of purity to prevent damage to the accumulators. 800 w. Elec, N. Y.—March 6, 1901. No. 40059.

Analysis.

Estimation of Metals by Electrolysis. Charles Nathan. Remarks on the history of electrolysis as applied to analysis, with description of apparatus and general conditions. 2000 w. Elec Chem & Met—Feb., 1901. Serial. 1st part. No. 39565 A.

Cells.

The Solvay Electrolytic Alkali Cell. John B. C. Kershaw. Illustrated description of the principles and design of this new form of cell. 600 w. Elect'n, Lond—March 15, 1901. No. 40048 A.

Electrochemistry.

Electrochemistry and Electrometallurgy. Francis B. Crocker. Part first presents the theory, discussing the principles and the general relation between the electrical quantities. 7000 w. Sch of Mines Quar—Jan., 1901. Serial. 1st part. No. 39768 D.

Electro-Metallurgy.

Electro-Metallurgy in Europe in 1900. John B. C. Kershaw. Reports concerning aluminum, copper, nickel, silver and gold, and zinc. 1800 w. Elec, N. Y.—March 20, 1901. No. 40060.

ELECTRO-PHYSICS.

Batteries.

Calculating a Battery for a Given Output. Dr. K. Norden. On the calculation of storage batteries for given discharge rates, referring to two papers recently published in German journals, and giving a method devised by the writer. 900 w. Elec Wld & Engr—March 9, 1901. No. 39748.

Clark Cell.

The Various Determinations of the E. M. F. of the Clark Cell. Henry S. Carhart. Reviews the various determinations made of the E. M. F. of the Clark Cell. 2000 w. Elec-Chem & Met—Feb., 1901. No. 39564 A.

Dielectrics.

Contributions to the Study of Dielectric Bodies (Neuere Beiträge zur Naturgeschichte Dielektrischer Körper). Dr. Moritz von Hoor. An elaborate study of condensers, using various materials as dielectrics. Many tables and diagrams are given. Three articles, 10000 w. Elektrotech Zeitschr—Feb. 21, 28, March 7, 1901. No. 39944 each B.

Expansion.

Magnetic Expansion of Iron and Nickel. Philip E. Shaw and S. C. Laws. Briefly reviews past research in this field, where the optical lever method has been adopted for measuring, and shows in this paper that these changes can be observed by an entirely different method, which has the advantages of greater delicacy and much greater range. Ill. 2200 w. Elect'n, Lond—Feb. 22, 1901. Serial. 1st part. No. 39595 A.

Oscillator.

A New Oscillator for Stationary Electrical Waves. Dr. Bernouilli. Brief illustrated description of the Blondlot-Coolidge oscillator, with remarks on the researches of Hertz and Lecher. 1000 w. Elect'n, Lond—March 8, 1901. No. 39801 A.

Theory.

The Propagation of Electrical Energy (Ueber die Fortpflanzung der Elektrischen Kraft). Dr. Gustav Platner. An examination of the various theories from the electrolytic point of view; discussing the relation between electrical and chemical energy. 5000 w. Electrochemische Zeitschr—Feb., 1901. No. 39952 H.

GENERATING STATIONS.

Armature Windings.

A Comparison of Dynamos with Surface-Wound and Slot-Wound Armatures. P. M. Heldt. Arguing that for small machines of given weight and angular velocity, at least 50 per cent. more output can be obtained if the armature is slot wound than if it is surface wound. 1000 w. Am Elect'n—March, 1901. No. 39683.

Dynamos.

Large Generators (Grosse Generatoren). A. Rothert. A study of dynamo design, comparing the writer's practice with that of Parshall and of Siemens & Halske. 5000 w. Elektrotech Zeitschr—Feb. 28, 1901. No. 39948 B.

The Schuckert Dynamo at the Paris Exposition (Les Dynamos Schuckert au Palais de l'Electricité). G. Leugny. With illustrations of continuous and polyphase generators and details of switchboards and distribution. 2500 w. Revue Technique—Feb. 10, 1901. No. 39905 D.

Excitation.

Alternator Excitation. H. H. Norris and F. D. Newbury. Discusses the various methods used in the United States and Europe. Ill. 4000 w. Sib Jour of Engng—March, 1901. No. 39845 C.

Generating Project.

The Generation and Transmission of Electric Energy at and from Coal Pit Centers. B. H. Thwaite. The first of a series of articles on long-distance transmission, showing the tendency of modern practice. 1000 w. Elec Rev, Lond—March 1, 1901. Serial. 1st part. No. 39692 A.

Power Station.

The Trafford Park Power Works. Illustrated detailed description of the first electrical station to be worked in England with the special object of supplying power in bulk to large manufacturers. 2800 w. Elec Engr, Lond—March 15, 1901. Serial, 1st part. No. 40023 A.

Transformers.

Rotary Transformers: Their History, Theory and Characteristics. George W. Colles. A thesis presented in candidature for the degree of Master of Science in the Columbian University. A review of transforming devices, tracing their evolution from early beginnings to the present. Ill. 4800 w. Jour Fr Inst—March, 1901. Serial. 1st part. No. 39643 D.

LIGHTING.

Arc Light.

A New Method of Producing Electric Light (Ein Neues Verfahren zur Erzeugung von Elektrischen Licht). Ewald Rasch. Describing an arc lamp with electrodes of magnesia, lime, or other refractory substance, rendered conductors by heating. 2500 w. Elektrotech Zeitschr—Feb. 14, 1901. No. 39942 B.

Incandescence.

The Osmium Lamp. On the new incandescent lamp invented by Dr. Auer von Welsbach, possessing a filament formed of the rare metal osmium. Also editorial. 1800 w. Elec Wld & Engr—March 16, 1901. No. 39841.

Lowestoft, Eng.

Lowestoft Electricity Works. An illustrated detailed description of the electric lighting installation. 2200 w. Elec Engr, Lond—March 1, 1901. No. 39724 A.

Ship Lighting.

Electric Lighting for German Ships. Gives extract of an article in the *Elektrotechnische Zeitschrift* treating of electrical installations on new ships of the German navy. Also remark on the use of accumulators for supplying electric light on ocean steamers. 600 w. U. S. Cons Repts, No. 973—Feb. 28, 1901. No. 39547 D.

Signs.

Automatic, Changeable Electric Signs. Illustrated description of a new form of electric sign advertising. 1500 w. Sci Am Sup—March 23, 1901. No. 39854.

Street Lighting.

Street Lighting of Cities. Henry H. Humphrey. Briefly discusses the subject generally, and gives an illustrated description of the principal engineering features of the new electric lighting system in St. Louis. 4300 w. Jour Assn of Engng Socs—Jan., 1901. No. 39577 C.

Thames Embankment.

The Electric Lighting of the Thames Embankment. Illustrated description of the arrangements so far as carried out, with outline of the previous history. 1700 w. Elect'n, Lond—March 1, 1901. No. 39721 A.

MEASUREMENT.

Bridge.

Three Forms of Thomson Bridge for Small Resistances (Drei Formen der Thomson'schen Messbrücke für Kleine Widerstände). Dr. M. T. Edelmann. With illustrations showing the wiring of three forms of bridge for low resistances and views of the completed instruments. 1000 w. Elektrotech Zeitschr—Feb. 14. 1901. No. 39943 B.

Hysteresis.

Measurements of Dielectric Hysteresis. W. E. Ayrton. A discussion of the results obtained by Mr. Mordey and by Mr. Mather for the County of London cable. Ill. 1500 w. Elec Rev, Lond—Feb. 22, 1901. No. 39601 A.

Meters.

Electric Meter for Three-Phase Currents with Four Conductors (Elektricitätszahler für Dreiphasenstrom mit Vier Leitungen). H. Aron. Showing the construction and connections of this special form of Aron Meter. 1200 w. Elektrotech Zeitschr—March 7, 1901. No. 39-954 B.

The Aron Meter for Mixed Three-Phase Currents (Compteur Aron pour Distributions Mixtes à Courants Triphasés). M. Aliamet. Showing the special winding adopted for use with mixed currents, with illustrations of the method of connection. 1200 w. Electricien—Feb. 23, 1901. No. 39933 B.

Slipping.

Measurement of the Slipping in Asynchronous Motors (Messung der Schlüpfung Asychroner Motoren). G. Seibt. The slip is determined from the vibrations of the needle of an amperemeter of which the terminals are connected to the contact rings of the armature. 1200 w. Elektrotech Zeitschr—Feb. 28, 1901. No. 39-949 B.

Voltage.

A Method of Compensating Voltmeters for the Voltage Drop in Long Feeders. M. B. Field. Describing an arrangement of voltmeters in connection with series resistances indicating the average voltage over the whole network at every moment. Serial. 1st Part. 2300 w. Electn, Lond—Feb. 22, 1901. No. 39598 A.

Wattmeters.

The Theory and Use of the Alternate Current Wattmeter. Charles V. Drysdale. An explanation of the use of this instrument for power measurement, the errors to which it is liable, and how to correct them. 4000 w. Elect'n, Lond—March 15, 1901. No. 40045 A.

POWER APPLICATIONS.

Armatures.

Resistance, Current Distribution and Consumption of Energy in Short-circuited Armatures (Widerstand, Stromvertheilung und Energieaufnahme von Kurzschlussankern). M. Osnos. An examination of the advantages of short-circuited armatures for induction motors, showing the saving in copper over phase armatures. 3000 w. Elecktrotech Zeitschr—Feb. 21, 1901. No. 39945 B.

Brake Magnets.

Brake Electromagnets for Continuous Currents (Ueber Bremselektromagnete für Gleichstrom). Max Vogelsang. Describing the solenoid magnets used by the Helios company for operating the brakes for electric cranes. 2500 w. Elektrotech Zeitschr—Feb. 21, 1901. No. 39946 B.

Business Building.

Power Plant of the Western Reserve Building. Illustrates the plant for furnishing power to a large addition to the building, occupied by large mining, shipping, steel and iron companies. The plant consists of two water-tube boilers, of the cross drum type, and three 30 kilo-watt direct connected generators. 1700 w. Engr, U. S. A.—March 1, 1901. No. 39625.

Cranes.

Electrically Driven Cranes (Elektrisch Betriebene Hebezeuge). P. Uellner. A description of electric travelling cranes, gantries, and cantilevers, built by the *Compagnie Internationale d'Electricité*, of Liége, Belgium. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—March 2, 1901. No. 39922 D.

Electrically Driven Cranes (Ueber Elektrisch Betriebe Hebezeuge). A. Kolben. With details of motors, gearing and general construction of traveling cranes, hoists, etc., showing the progress made in the past five years. 3000 w. Elektrotech Zeitschr—Feb. 14, 1901. No. 39941 B.

100-Ton Electric Ladle Crane. An illustrated detailed description of a crane recently erected in an open-hearth shop for handling a 50-ton ladle for making large ingots for gun forgings. 1500 w. Engr, Lond—March 8, 1901. No. 39808 A.

Fans.

Development of Motor Fans. Alton D. Adams. Discusses briefly the early fan motors; the design of fan motors, and those in present use. 4000 w. Elec Wld & Engr—March 2, 1901. No. 39621.

Hoboken, N. J.

The Hoboken Power Plant of the United Electric Company of New Jersey. Illustrates and describes a plant changed from a belted plant containing engines and generators of various types and capacities, to a modern plant of direct-connected units, and the change of e. m. f. from 1040 to 2400, all accomplished without shutting down any circuit. 1500 w. Elec Wld & Engr—March 23, 1901. No. 40009.

Mining Plant.

Electrically Operated Mines in Europe. Frank C. Perkins. Illustrates and describes the Ferdnandsgrube electrical pumping plant, and the electric mine ventilators at Karwin. 600 w. Eng & Min Jour—March 30, 1901. No. 40086.

Electric Power Plant at the Hollertszug

Iron Ore Mine, Herdorf on the Sieg, Germany. States the conditions to be met, and gives illustrated description of the plant installed. 2300 w. Ir & Coal Trds Rev—Feb. 22, 1901. No. 39611 A.

Motor Regulation.

The Speed Control of Electric Motors. G. F. Packard. Describes the method which consists in varying the speed by varying the volume and pole face distribution of the magnetic flux. 1100 w. Ir Age —March 7, 1901. No. 39619.

Motors.

A New Arrangement of Motors (Eine Neue Motorschaltung). Hugo Grob. Describing a special method of connecting polyphase motors in series. 2500 w. Elektrotech Zeitschr—March 7, 1901. No. 39953 B.

Packing House.

Power Plant of the Cudahy Packing Co. Illustrates and describes a Kansas City plant, the power being furnished by two simple Buckeye engines, direct-connected to Crocker-Wheeler generators. 2500 w. Engr, U. S. A.—March 1, 1901. No. 39624.

Power Bills.

The Electrical Power Bills of 1900; Before and After. William L. Magden. Read before the Inst. of Elec. Engs. (Eng.). Considers the conditions which led to the bills of the past session, describes some of the main features of the bills, and urges the Inst. to determine what its attitude should be in regard to the application of electrical energy in England. 4800 w. Elect'n, Lond—March 1, 1901. Serial. 1st part. No. 39722 A.

Signs.

The Evolution of the Electric Sign. E. Trier. Illustrates and describes the various kinds of electric signs, especially those operated automatically. 1300 w. Elec Wld & Engr—March 2, 1901. No. 39622.

Voting.

Voting by Electricity. Describes a device it is proposed to place in the House of Representatives at Washington, enabling Representatives to vote and have their votes recorded and counted and displayed by electricity. 800 w. Elec Wld & Engr —March 23, 1901. No. 40012.

Workshop Driving.

Electrical Power in British Works. W. Geipel. Read before the Gloucester Engng. Soc. Briefly reviews the older methods of operating, showing the losses, and considers how far electricity can assist in overcoming these losses. 4200 w. Elec Rev, Lond—Feb. 22, 1901. Serial. 1st part. No. 39602 A.

TRANSMISSION.

Line Wire.

The Use of Aluminum Line Wire and Some Constants for Transmission Lines. F. A. C. Perrine and F. G. Baum. Discussion of the above named paper. 3800 w. Trans Am Inst of Elec Engs—Feb., 1901. No. 40000 D.

Long Distance.

Electrical Transmission from Coal Mines. Fred Wilson Hart. An illustrated account of the power for the Cochiti Gold Mining Co., transmitted 32 miles from the coal deposits at Madrid, New Mexico, with comparison of the old and new methods. 2800 w. Elec Wld & Engr—March 2, 1901. No. 39620.

Mine Transmission.

Electrical Transmission Direct from the Coal Mine. Frank C. Perkins. Brief illustrated description of a German coal mine plant at Easen-Ruhr, the current being used for lighting and power. 700 w. Ir Age—March 21, 1901. No. 39817.

Snoqualmie Falls.

The Power Transmission From Snoqualmie Falls. An illustrated detailed description of this great transmission plant of Washington, with a discussion of its topographical and meteorological features, by Charles H. Baker. 13600 w. Jour of Elec—Jan., 1901. No. 39849 C.

MISCELLANY.

Education.

On the Training of Electrical Engineers. John T. Nicolson. Abstract of a paper read before the Manchester Section of the Inst. of Elec. Engs. Urges the adoption of the laboratory in connection with schools of applied science, and gives suggestions as to the instruction desirable. 4200 w. Elect'n, Lond—Feb. 22, 1901. No. 39597 A.

Electrical Exports.

American Electrical Exports. Arthur Stanley Riggs. Discusses some of the conditions in China, Japan and the Turkish Empire favorable to export. 2700 w. Elec Rev, N. Y.—March 9, 1901. Serial. 1st part. No. 39716.

Nineteenth Century.

Important European Electrical and Engineering Developments at the Close of the Nineteenth Century. William J. Hammer. Illustrated detailed descriptions of the telephonograph, the Langen mono-rail, Nernst lamp, osmium lamp, gas engines, steam turbine, and other important inventions. 20600 w. Trans Am Inst of Elec Engs—Feb., 1901. No. 40003 D.

GAS ENGINEERING

Address.

Presidential Address at the Birmingham Meeting of the Midland Association of Gas Managers. Thomas Glover. A lengthy address dealing with many subjects of interest to gas engineers. Considers water gas, inclined retorts, naphthalene, distribution, coke ovens, burners, etc. Ill. 9600 w. Gas Wld—Feb. 23, 1901. No. 39599 A.

Presidential Address before the Manchester District Institution of Gas Engineers. Charles Wood. Relates the practice and experience at Bradford, Eng., and discusses some points of interest. 7800 w. Jour Gas Lgt—March 5, 1901. No. 39-783 A.

Presidential Address before the Southern District Association of Gas Engineers and Managers. Corbet Woodall. The main theme of the address is public lighting, but other matters of interest are considered. 6500 w. Gas Wld—March 16, 1901. No. 40024 A.

Analytical Tests.

Some Analytical Tests Made in a Gas-Works Laboratory. F. G. Barber. Read before the Manchester and Dist. Jun. Gas Assn. Considers methods of testing purified gas for impurities; analysis of the bodies which rid the gas of its impurities; coal gas; by products, and special tests. 5000 w. Jour Gas Lgt—March 12, 1901. No. 39863 A.

Conveying Plant.

New Hot-Coke Conveying Plant at the Leeds Gas-Works. Illustrated detailed description. 2000 w. Jour of Gas Lgt—March 19, 1901. No. 40066 A.

Enrichment.

The Enrichment of Coal Gas. R. Hooton. Read before the Manchester Dist. Inst. of Gas Engs. Short paper introducing a general discussion of the subject. 5700 w. Jour Gas Lgt—March 5, 1901. No. 39784 A.

The Enrichment of Coal Gas. Report of the discussion at the meeting of the Manchester Dist. Inst. of Gas Engs. 6000 w. Gas Wld—March 16, 1901. No. 40-025 A.

European Practice.

How They Do Things on the Other Side. F. H. Shelton. A paper read before the New England Assn. of Gas Engs. Notes on visits to 15 gas-works in Europe. 7700 w. Pro Age—March 1, 1901. No. 39566.

Gas Fires.

Radiant Heat from Different Varieties of Gas Fires. Thomas Fletcher. Reports measurements of asbestos fibre, ball fire, iron spray, and radiant reflectors. Shows the iron spray to be the most economical and effective. 700 w. Jour Gas Lgt—March 5, 1901. No. 39782 A.

Governors.

Some Sketches of Gas Governors. J. J. Humphreys, Jr. Read before the New England Assn. of Gas Engs. Reviews the history of gas governors, illustrating many types and giving brief descriptions. General discussion. 5800 w. Am Gas Lgt Jour—March 11, 1901. No. 39750.

Ignition.

Automatic Ignition of Gas. W. G. Hicks. Illustrates a new device and discusses the faults of those generally used. 1300 w. Jour Gas Lgt—March 5, 1901. No. 39781 A.

Incandescence.

Relation of Heating to Lighting. Power of Gas, with Special Reference to Incandescent Mantles. Herman Russell and Alfred H. White. Discusses the subject of testing incandescent mantles, and tests made, giving conclusions. 3300 w. Pro Age—March 15, 1901. No. 39788.

Maps.

Street Maps. Read before the Michigan Gas Assn. Illustrates and describes maps prepared for a gas company and found very satisfactory. 4600 w. Pro Age—March 15, 1901. No. 39787.

Paris Exposition.

Gas Lighting at the Paris Exposition. Walter S. Allen. Describes features of the exhibit of special interest to gas men. Discussion. 4500 w. Am Gas Lgt Jour—March 4, 1901. No. 39654.

Purification.

Remarks on Gas Purification. S. J. Fowler. Presented at meeting of the New England Assn. of Gas Engs. Describes the apparatus used at Springfield, Mass., the changes made and the reasons. Brief discussion. 2000 w. Am Gas Lgt Jour—March 4, 1901. No. 39652.

The Proportion of Sulphur Removed in Each Purifying Box. Carroll Miller. Read at meeting of the New England Assn. of Gas Engs. Describes the apparatus used and experiments made to determine the proportional amount of sulphur in the form of sulphuretted hydrogen removed from the gas by the oxide of iron in each box in a set of four. Discussion. 2500 w. Am Gas Lgt Jour—March 4, 1901. No. 39653.

Water Gas.

Carburetted Water Gas. Samuel Cutler, Jr. Abstract of paper read before the Inst. of Junior Engs. discussing the composition, chemical aspects, methods, etc. Ill. 4800 w. Jour Gas Lgt—March 5, 1901. No. 39785 A.

MARINE AND NAVAL ENGINEERING

Battleship.

The New Battleship "Russell." Describes one of the largest battleships of the British navy recently launched; the first of six, known as the Duncan class, which are also the fastest battleships of the navy. 2600 w. Engng—Feb. 22, 1901. No. 39607 A.

The New Italian Battleship Vittorio Emanuele III. Illustrated description of a novel design about to be built by Italy. 1200 w. Engr, Lond—March 15, 1901. No. 40039 A.

Boilers.

Babcock and Wilcox Boilers on the S. S. "Martello." Illustrated description of new boilers recently substituted for the return tube boilers. 1100 w. Engng—Feb. 22, 1901. No. 39604 A.

On Some Attempts to Increase the Efficiency of Marine Boilers. G. M. Brown. Read before the North East Coast Inst. of Engs. & Shipbuilders. Discusses the utilization of the heat of waste gases, the experiments of Mr. Isherwood, the use of retarders, etc. Ill. 4500 w. Engs' Gaz—March, 1901. No. 39720 A.

The Thornycroft-Marshall Water-Tube Boiler. Illustrated description of a new form of water-tube boiler. 1700 w. Engng—March 15, 1901. No. 40032 A.

Water-Tube Boilers in the Navy. Interim report of the committee appointed to examine into the suitability of various types of marine boilers for naval purposes, with editorial. 6000 w. Engng—March 15, 1901. No. 40034 A.

Cargoes.

Importance of Economizing Tonnage Facilities by Compact Stowage of Cargoes. Henry P. Jones. A discussion of matters relating to ocean transportation, especially the export of cotton. 2000 w. Eng News—Feb. 28, 1901. No. 39572.

Coaling.

The Coaling of Warships. J. R. Edwards. A full discussion of the question; need of improvements in bunkers, rapidity, best means of coaling warships, use of Temperley conveyors, coaling stations, and coal-handling appliances, coaling at sea, the Clarke automatic coaling and weighing barge, the Walsh coal and freight delivery vessels, the Miller marine cableway, and other related matters. Ill. 16500 w. Jour Am Soc of Nav Engs—Feb., 1901. No. 39587 H.

Cruisers.

British Armored Cruisers. Editorial discussion of recently launched battleships and cruisers. 2000 w. Engng—March 1, 1901. No. 39726 A.

Comment on the New Type of United States Protected Cruisers. T. H. Thomas. Brief review of the history of the cruisers, St. Louis, Milwaukee and Charleston, the bids for construction of which were received on February 1. Ill. 1500 w. Marine Engng—March, 1901. No. 39678 C.

H. M. S. "Good Hope" and "Bacchante." Engraving showing the stern of the "Good Hope" and the arrangement of the balanced rudder and the cutting away of the dead wood, with brief description. 1500 w. Engr, Lond—March 1, 1901. No. 39731 A.

Deutschland.

The Hamburg-American Liner "Deutschland." An illustrated description of interesting details of this fine Atlantic liner. 700 w. Engng—March 8, 1901. Serial. 1st part. No. 39815 A.

The Steamship "Deutschland" (Le Paquebot Transatlantique "Deutschland"). S. Gradier. A fully illustrated description of the Hamburg-American Line steamer. Two articles. 2 plates. 5000 w. Génie Civil—Feb. 16, 23, 1901. No. 39900 each D.

Dockyards.

Keyham Dockyard Extension. Illustrated description of a great extension scheme, to cost over £3,000,000 sterling, now under construction. It consists of a tidal basin, a closed basin with an entrance lock, and three graving docks. 2800 w. Transport—March 1, 1901. No. 39687 A.

Explosion.

Steam Pipe Explosion on S. S. Ventura Instantly Kills Five Men. An illustrated article giving an account of the mishap and the investigation into the causes. 2000 w. Marine Engng—March, 1901. No. 39677 C.

Ferryboat.

Elegant New Propeller Ferryboat. Illustrated description of the "West Point," the latest addition to the N. Y. harbor fleet. 1400 w. Naut Gaz—March 7, 1901. No. 39701.

Freighters.

Ocean Freighters Alaskan and Arizonian Building at Union Iron Works. Describes two interesting ships under construction at San Francisco, representing the most advanced practice of ocean going freighters. 1100 w. Marine Engng—March, 1901. No. 39680 C.

Fuel.

Petroleum Fuel for Ships; The Theory Exploded. Discusses the advantages and disadvantages of this fuel, and does not think it likely to come into general use. 1800 w. Ir & Coal Trds Rev—Feb. 22, 1901. No. 39613 A.

Marine Railway.

The Marine Railway at the Royal Dock at Friedrichshafen (Der Schiffsaufzug der Kgl. Werft in Friedrichshafen). A. Seeman. The railway is at Friedrichshafen on the Lake of Constance and enables the lake steamers of 175 feet in length drawing 5 feet of water to be hauled out of the water for inspection and repair. 4000 w. Zeitschr d Ver Deutschr Ing—Feb. 23, 1901. No. 39920 D.

Passenger Boats.

New Fast Light-Draft River Propellers. Illustration and description of two fine passenger boats now being built for service on the upper Delaware. 1300 w. Naut Gaz—March 14, 1901. No. 39833.

Powder.

Smokeless Powder. Editorial discussion of the powder used by the British and its disadvantages, quoting from the address of Lieut. A. T. Dawson. 2100 w. Engng—March 15, 1901. No. 40036 A.

Powering.

The Powering of Ships. William Ledyard Cathcart. Presents the results of the best modern practice. Discusses the problem of resistance in its various forms, and of losses, model experiments, etc., and concludes that speed and power curves give the most trustworthy means of powering a proposed ship. Ill. 17800 w. Sch of Mines Quar—Jan., 1901. No. 39770 D.

Projectiles.

Capped Armor-Piercing Projectiles. P. M. Staunton. Deals with the development of each successive type, stating what it was intended to effect, and to what extent the expectations have been justified. 5200 w. Engng—March 15, 1901. No. 40035 A.

Schooners.

Modern American Wooden Schooners. Descriptions of two of the latest to be launched from Maine shipyards. 1100 w. Naut Gaz—March 21, 1901. No. 39865.

Shipbuilding.

Camden's Great Shipbuilding Plant. Describes the works of the New York Shipbuilding Co., the novel labor-saving appliances, the power, railroad connections, etc. 7500 w. Naut Gaz—March 21, 1901. No. 39866.

Decline in British Shipbuilding. Reports this branch of trade, as well as other lines, in anything but a prosperous condition. 2400 w. Naut Gaz—March 14, 1901. No. 39834.

New American Steel Shipbuilding Plants. Waldon Fawcett. A review of the new plants and improvements greatly increasing the American facilities. 2800 w. Ir Age—March 14, 1901. No. 39755.

Notes Taken at the Works of the Newport News Shipbuilding and Drydock Co., Newport News, Va. General information with illustrated description of the shops, important tools, special work, etc. 3000 w. Mach, N. Y.—March, 1901. No. 39663.

Ship Building in the United States. A discussion of the subject based upon the output at Cleveland as compared with other districts of the country. 1200 w. Marine Rev—March 21, 1901. No. 40013.

Ship Building Resources of Germany. From *N. Y. Sun*. Full text of M. Edouard Lockroy's letter on the merchant marine of Germany and the remarkable industrial growth of the nation. 3300 w. Marine Rev—March 21, 1901. No. 40014.

Sloop.

The Sloop-of-War St. Mary's. Illustrations with description and a summary of her history from the time of launching, her part in the Civil War, and her use as a Public Marine School, with a brief article describing life on board. 3800 w. Rudder—March, 1901. No. 39779 D.

Speed.

Speed of Steamers. Theodore Lucas. Discusses methods for finding the right horsepower and corresponding weight of machinery for a given displacement at a given speed, and gives information derived from experiments, diagrams, calculations, etc. 2000 w. Naut Gaz—March 7, 1901. No. 39702.

Steaming.

The Steaming Radius of United States Naval Vessels. B. C. Bryan. Gives tabulated information showing steaming radius of U. S. naval vessels, compiled from data of actual runs, as shown by steam logs, with comments. 3800 w. Jour Am Soc of Nav Engs—Feb., 1901. No. 39588 H.

Steamships.

New Lake-Built Ocean Passenger and Freight Steamships. Briefly describes two steel vessels now under construction at Toledo, Ohio. Ill. 1000 w. Naut Gaz—March 21, 1901. No. 39864.

Submarine.

Holland's Speed Endurance Trial. A not very favorable report from Lieut. Com. John R. Edwards of the U. S. Navy. 3500 w. Marine Rev—March 7, 1901. No. 39754.

Gasoline Engines for Holland Submarine Torpedo Vessels Nos. 3 to 8. John Saltar, Jr. Reviews the history of the modern gas engine briefly, and describes the engines being built for these boats. 2200 w. Jour Am Soc of Nav Engs—Feb., 1901. No. 39589 H.

Submarine Navigation (La Navigation Sons-Marine). H. Noalhat. A complete study of the action of the various forces upon a submerged boat. Serial. Part I. 3000 w. Revue Technique—Feb. 25, 1901. No. 39907 D.

The Holland Submarine Boat. Report prepared by Rear-Admiral O'Neil on the submarine boat Holland, with editorial. 6000 w. Engr, Lond—March 1, 1901. No. 39732 A.

Surf-Boat.

The U. S. Life-Saving Service Self-Bailing Water Ballast Surf-Boat. C. H. M'Lellan. Describes a useful and recent improvement in appliances for this service. Ill. 4400 w. Marine Engng—March, 1901. No. 39679 C.

Transports.

Transport Service to the Philippines. An account of the work of the Quartermaster's Department, especially the transportation of troops and supplies to the Philippines. Ill. 2000 w. Sci Am—March 23, 1901. Serial. 1st part. No. 39852.

Water-Ballast.

Rolling of Ships and the Effect of Water-Ballast. Bernard C. Laws. Read before the Inst. of Engs. & Shipbuilders in Scotland. Discusses the placing of the ballast so as to secure stability best for the particular vessel, and least calculated to produce excessive rolling. 3300 w. Engs' Gaz—March, 1901. No. 39719 A.

Yachts.

New Measurements for Yachts. Concerning the new rules adopted by the Seawanhaka Corinthian Yacht Club and which may become universal. 2400 w. Naut Gaz—March 14, 1901. No. 39835.

The New Cup Defender "Independence." Particulars of the Lawson boat building in East Boston with other items of interest connected with the coming international yacht races. 6000 w. Naut Gaz—March 7, 1901. No. 39703.

Yacht Yards.

A Flying Trip to Some English Yacht Yards in 1899. N. L. Stebbins. An account of visits to well-known yards with interesting illustrations. 2000 w. Rudder—March, 1901. No. 39780 D.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Agriculture.

Automobilism in Agriculture. Illustrates and describes several appliances shown at Paris, for plowing, mowing and other work. 1200 w. Sci Am Sup—March 16, 1901. No. 39778.

Artillery Motor.

A Motor Field Battery. Abstract of a paper read before the Royal Artillery Institution by Major H. A. Bethell. A discussion of the advantages and objections; giving also the details of a design for hauling guns by motor vehicles, which seems to promise well. 3000 w. Autocar—March 16, 1901. No. 40019 A.

Canada.

The Automobile Industry and Its Development in Canada. Briefly discusses the subject in general, and the progress in Canada. Ill. 3300 w. Can Elec News—March, 1901. No. 39861.

Carburetters.

Carburetters Condemned. Hugh Dolnar. Proving that the commonly used forms of carburetters are needless and troublesome, and briefly describing some recent patents for introducing liquid fuel to a motor cylinder. Ill. 2000 w. Autocar—Feb. 23, 1901. No. 39591 A.

Cost.

A Few Figures on Cost of Operating a Steam Automobile. George E. Greenleaf. Describes the carriage used and conditions under which it was run, giving a detailed statement of the cost of running. 1200 w. Auto Mag—April, 1901. No. 40049 C.

Explosion Motors.

Theoretical Calculations Concerning High-Speed Explosion Engines. P. Colardeau. Gives a method of calculating dimensions and powers within certain limits; the formulæ have been established as the results of trials and observations. 1800 w. Auto Jour—March, 1901. No. 40017 A.

Gasoline Carriage.

Design of a Light Gasoline Carriage. Illustrates and describes a design aiming to be as simple as is consistent with efficiency and strength. 2700 w. Horseless Age—March 13, 1901. No. 39758.

Ignition.

Ignition Wiring Methods. Dr. Henry Power. An illustrated discussion of the electric ignition problem as applied to gasoline engines. 600 w. Horseless Age—Feb. 27, 1901. Serial. 1st part. No. 39555.

Motor Difficulties.

Air-Cooled Motor Difficulties and How to Overcome Them. T. Parker Hall, Jr. An account of the writer's experiments and the lessons learned from them. 2000 w. Horseless Age—March 27, 1901. No. 40067.

Paris.

Motor Cars in Paris. Discusses the

progress being made in motive power, in transmission gears and other details. 1300 w. Engr, Lond—March 8, 1901. No. 39806 A.

Sparking.

Sparking Troubles. A discussion of the causes and remedies of sparking, written especially for users of gasoline automobiles or stationary gasoline engines. Ill. 3000 w. Horseless Age—March 20, 1901. No. 39848.

Steam Wagon.

The Thornycroft Steam Wagon. Illustrates and describes the American built wagons for heavy duty, which possess many interesting features. 1400 w. Ir Age—March 28, 1901. No. 40058.

Trials.

An Automobile Trial. J. L. Lucas. History of a trial run of an auto-carriage run by a kerosene burner using a flash boiler and an ordinary 4½ h. p. engine. 1100 w. Am Mach—March 21, 1901. No. 39868.

Electric Automobiles at Chislehurst. Review of the judges' report of trials made under the auspices of the Automobile Club of Great Britain and Ireland. 2000 w. Elec Rev, Lond—March 1, 1901. No. 39694 A.

Truck.

Electric Truck (Chariot Electrique). A. Bainville. Illustrated description of the heavy electric truck of 12 tons weight and 10 tons capacity used by the Say refinery of Paris. 1800 w. Electricien—Feb. 16, 1901. No. 39931 B.

Voiturette.

The Panhard Voiturette. Illustrated description of the carriage and mechanism. 1200 w. Autocar—Feb. 23, 1901. No. 39590 A.

HYDRAULICS.

Air Compression.

Water Power by Direct Air Compression. William O. Webber. Reviews some of the uses of compressed air and the old methods of mechanical compression, and also the methods of compressing air directly by falling water or under pressure. Ill. 3500 w. Jour Assn of Engng Socs—Jan., 1901. No. 39578 C.

Excavation.

Hydraulic Excavation. Latham Anderson. Discusses the processes employed, and the conditions essential to economy, outlining the process of opening and working on hydraulic mine, and other work of interest. Ill. 5500 w. Jour Assn of Engng Socs—Jan, 1901. No. 39576 C.

Pumping Engine.

A Report on Trial of 30,000,000 Gallon Pumping Engine at the Chestnut Hill High-Service Station of the Metropolitan Water Works, Made May 1 and 2, 1900. Will J. Sands. Gives a description of the plant and method of conducting the trial, with general data. 3400 w. Jour N. E. Water Wks Assn—March, 1901. No. 39637 F.

Pumps.

The Bridgeport Wheel Pumps. Ossian Guthrie. Describes the construction of two wheel pumps used between 1848 and 1871 for supplying the Illinois and Michigan Canal with a flow from the river. They proved an economical and efficient device and their advantages are urged for the purpose of elevating sewage and storm water into the big cross-town tunnels in Chicago. Plate. 1500 w. Jour W Soc of Engs—Feb., 1901. No. 39767 D.

The Kaselowsky-Prott Hydraulic Pump. Fr. Frolich. Translated from *Gluckauf*. An illustrated detailed description of improvements in the hydraulic pump which greatly increase its efficiency. 1500 w. Ir & Coal Trds Rev—Feb. 22, 1901. No. 39612 A.

Water-Wheels.

Some Recent High-Head Pelton Water Wheel Installations. George J. Henry, Jr. Illustrated account of some of the most prominent and recent installations of Pelton wheels in electric power transmission service. 3300 w. Jour of Elec—Jan., 1901. No. 39850 C.

MACHINE WORKS AND FOUNDRIES.

Artillery.

Modern Artillery. Arthur Trevor Dawson. Considers general governing principles and compares the different systems employed with a view of ascertaining the relative advantages and disadvantages. 10000 w. Jour Soc of Arts—March 8, 1901. No. 39800 A.

Nordenfelt's Quick-Firing Field Artillery. An illustrated description of field guns fitted with breech mechanism of the eccentric screw type, and carriages without hydraulic brake, in which the force of the recoil is taken up by a special wheel-brake. 3200 w. Engng—March 1, 1901. No. 39725 A.

Rapid Fire Guns, Ancient and Modern. E. G. Parkhurst. Illustrated description of ancient and modern guns of this class. 3500 w. Am. Mach—March 7, 1901. No. 39675.

The Manufacture of American Ordnance. Waldon Fawcett. Reviews the work of the past year at the different U. S. arsenals and machine works, illustrating many of the guns and describing the methods. 2500 w. Am Mfr—March 7, 1901. No. 39688.

The Manufacture of Rapid Fire Guns. E. G. Parkhurst. The present article deals with the material, the physical tests, the leading operations and tools used. 2000 w. Ill. Am Mach—March 14, 1901. Serial. 1st part. No. 39759.

Bolts.

Bolts, Nuts, and Keys, and the Part They Play in Locomotive and Car Work. A topical discussion. Ill. 4500 w. Pro W Ry Club—Feb., 1901. No. 39829 C.

Brazing.

Brazing Solder. John Findlay. From *The Indian Textile Journal.* Describes the methods in use for making brazing solder, and gives the best mixtures for brazing brass, copper and steel. 600 w. Prac Engr—March 15, 1901. No. 40044 A.

Cam-Cutting.

Uniform Feed Cam-Cutting Machine. Illustrated description of an interesting cam-cutting machine used in the manufacture of cash registers. 700 w. Am Mach —Feb. 28, 1901. No. 39540.

Castings.

A Straight Casting from a Crooked Old Pattern. L. C. Jewett. Describes the method used with success. Ill. 900 w. Am Mach—March 21, 1901. No. 39867.

Copper Castings. Walter J. May. Directions for casting sound castings of this metal. 800 w. Prac Engr—March 15, 1901. No. 40043 A.

Cranes.

See Electrical Engineering, Power Applications.

Dies.

Solid and Built Up Dies. G. Schneider. Illustrates and describes a proposed die and its substitute. 900 w. Am Mach—March 14, 1901. No. 39761.

Wiring Dies for Shell Work. Joseph V. Woodworth. Illustrated description of dies for forming a sheet-brass shell. 600 w. Am Mach—March 14. 1901. No. 39760.

Forge.

The Old Boonton Forge. Brief illustrated description of a pre-revolutionary foundry where cannon balls were cast for the continental army, which is about to disappear in the building of a great reservoir. 600 w. Sci Am—March 16, 1901. No. 39773.

Lubrication.

The Friction of Lubricants at High Temperatures. (Die Reibung von Schmierölen bei Höheren Wärmegraden.) Dr. S. Kapff. A review of the experiments of Prof. Thurston and a comparison with German experiences as to temperature and viscosity. 2000 w. Zeitschr d ver Deutscher Ing—March 9. 1901. No. 39925 D.

Pattern Making.

Pattern and Core Boxes for a Water Jacketed Cylinder. W. O. Anthony. Illustrated description of the methods employed in the making of a set of patterns for a water jacketed cylinder and head. 1600 w. Horseless Age—March 6, 1901. Serial. 1st part. No. 39662.

Shop Construction.

The Cramp Machine Shop and Power House. Illustrated description of a 333 x 142 ft. steel frame machine shop and a 60 x 71 ft. power house; the description is confined to the structural details of the building. 2300 w. Eng Rec—March 9, 1901. No. 39699.

The New Detroit Shops of the Boyer Machine Company. New shops prepared for a company removing from St. Louis are illustrated and described in detail. 2200 w. Am Mach—March 7, 1901. No. 39676.

The New Works of the Alabama Steel and Shipbuilding Company. Archibald Potter Head. Illustrated description, with history and other information. 5000 w. Ir & Coal Trds Rev—March 15, 1901. No. 40028 A.

The Schenectady Works of the General Electric Company. The first of a series of articles giving illustrated description of the equipment of these fine shops. The present paper gives a general view of the works and the methods. 2200 w. Elec Rev, N. Y.—March 16, 1901. Serial. 1st part. No. 39786.

Shop Hygiene.

The Economy of Heating and Ventilating the Machine Shop. L. Allen. A discussion of the influence of personal comfort upon individual efficiency, showing how bad hygienic conditions reduce quality and rate of out-put. 3000 w. Engineering Magazine—April, 1901. No. 39966 B.

Tubing.

Diescher Billet Piercing Process. Illustrated description of a new method for piercing billets to be used in the manufacture of seamless tubing. Gives illustrations showing the important steps in the art since its introduction by M. Mannesmann in Germany. 1800 w. Ir Trd Rev—Feb. 28, 1901. No. 39548.

Workshop Driving.

See Electrical Engineering, Power Applications.

MATERIALS OF CONSTRUCTION.

Rubber.

The Recovery of Naphtha in India-Rubber Works. Calls attention to points connected with the recovery and means of obtaining satisfactory results. 2400 w. Engng—March 8, 1901. No. 39816 A.

Steel.

An Experimental Study of the Causes of the Fragility of Steel (Etude Experimentale des Causes de la Fragilité de l'Acier). Ch. Fremont. The method of M. Fremont of bending tests of small cross-ruled bars is employed to investigate the nature and deformation of brittle steels. 5000 w. Bull Soc d'Encour—Feb., 1901. No. 39912 G.

Microstructure of the Steel in a Defective Circular Saw. James A. Aupperle. Brief illustrated account of microscopic examination to determine the cause of the failure. 450 w. Eng News—March 7, 1901. No. 39670.

POWER AND TRANSMISSION.

Ball Bearings.

Experiments on the Permissible Pressure on Ball Bearings (Versuche über die Zulässige Belastung von Kugeln und Kugellagern). Dr. W. Schwinning. Experiments to determine the deformation and crushing resistance of balls under the conditions of use for bearings. 3000 w. Zeitschr d Ver Deutscher Ing—March 9, 1901. No. 39923 D.

Belts.

Belt Drive for Three Pulleys. Forrest R. Jones. Calculations where two pulleys are driven with a single belt by a third pulley. 2000 w. Mach, N. Y.—March, 1901. No. 39664.

High-Speed Belt Transmission. A report of statements by C. O. Gehrckens on experiments with very high speed belts, claimed to disprove the theories of Rankine and others on this subject. 1600 w. Eng Rec—March 30, 1901. No. 40079.

Compressed Air.

Compressed Air. Considers its compression, storage and distribution, and its use as a motive power. 2500 w. Auto Jour—March, 1901. Serial. 1st part. No. 40018 A.

Dynamometer.

Electric Precision Brake-Dynamometer (Elektrisches Präcisions Bremsdynamometer). E. H. Rieter. The device is similar to a Prony brake, with the friction band replaced by a ring magnetic field. The heat generated is dissipated by air-cooled ribs. 2000 w. Elektrotech Zeitschr—Feb. 28, 1901. No. 39950 B.

The Design and Installation of an Alden Absorption Dynamometer. C. M. Allen. Illustrates and describes this apparatus and its operation. It is compact, easily handled and automatic in regulation. 1400 w. Jour Worcester Poly Inst—March, 1901. No. 39843 C.

Gearing.

Construction of Lobed Wheels. Robert A. Bruce. An illustrated description of a method of constructing lobed gearing. 2300 w. Prac Engr—Feb. 22, 1901. Serial. 1st part. No. 39594 A.

Pipe Lines.

Petroleum Oil Pipe Lines. A. S. Cooper. Considers the cases that may arise in constructing an oil line, means of finding the fluidity of the oil and therefore the flow. Ill. 1600 w. Min & Sci Pr—March 9, 1901. No. 39757.

Wire Ropes.

Wire ropes. J. T. Beard. A reference to some important facts shown by experiments described in a paper by Andrew S. Biggart, in Pro. Inst. of Civ. Engs. 3000 w. Mines & Min—March, 1901. No. 39-713 C.

SPECIAL MOTORS.

Explosion Motors.

See Automobilism.

Gas Engines.

A Test of a Gas Engine Electric Lighting Plant. H. N. Cheney read before the New England Assn of Gas Engs. Describes a test made at the Mechanics' Building, Boston, of a plant used for exhibition purposes at a fair. Ill. and discussion. 8,000 w. Am Gas Lgt Jour—March 11, 1901. No. 39749.

Tests of a Gas Engine Using Electric and Hot-Tube Igniters. An account of some tests made in Boston on a 20-H. P., two-cylinder engine at various loads. 600 w. Eng Rec—March 30, 1901. No. 40078.

Tests of Gas Motors and Generators (Essais de Moteurs à Gaz et de Gazogènes). An account of tests of Crossley gas engines and Pierson generators at the tramway station at Cassel (France). 1200 w. Génie Civil—Feb. 23, 1901. No. 39901 D.

The Insistent Operative Conditions of the Gas Engine. W. Osborne. On the importance of having an intelligent engineer to so regulate the engine as to bring the best conditions for efficiency. 1400 w. Am Mach—Feb. 28, 1901. No. 39541.

Fly Wheels.

The Computation of Fly Wheels for Internal Combustion Motors (Berechnung des Schwungradgewichtes der Verbrennungsmotoren). H. Güldner. A discussion of the proper weight for two and four cycle motors to give a predetermined steadiness of motion. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—March 16, 1901. No. 39926 D.

See Steam Engineering.

Heat Engines.

A Method of Cyclic Analysis of Heat Engines. Charles E. Lucke. Outlines various cycles and considers them, causing one pound of air to pass through each under ideal conditions. Mathematical. 4000 w. Sch of Mines Quar—Jan., 1901. Serial. 1st part. No. 39771 D.

Internal Combustion.

The Secor Internal Combustion Engine. John A. Secor. States the present position of gas engines and gives illustrated description of engine named. 3300 w. Eng News—March 28, 1901. No. 40057.

Solar Motors.

Solar Motors. Charles F. Holder. An illustrated description of a solar motor at work at Los Angeles, Cal., with history of its development. 1500 w. Sci Am—March 16, 1901. No. 39777.

STEAM ENGINEERING.

Blowing Engine.

Horizontal Blowing Engine with Suspended Valves (Liegende Hochofen-Gebläsemaschine mit Lenkerventilen). H. Hoerbiger. Illustrated description of engine for blast furnace service. The air valves are supported on spring links. 4500 w. 2 plates. Zeitschr d Ver Deutsch Ing—Feb. 16, 1901. No. 39917 D.

Boilers.

The Steam Boilers at the Paris Exposition (Die Dampfkessel der Pariser Weltausstellung). F. Krauss. A general review of the steam boilers exhibited at Paris, with details of arrangement and construction. Serial. Part I. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—March 8, 1901. No. 39929 B.

See Marine & Naval Engineering.

Condensers.

Condensers for Steam Engines (Les Condenseurs de Machines à Vapeur). J. Nadal. The first portion of an exhaustive study of the advantages of the use of condensers, and a description of modern condensing machinery for use with steam engines. Serial. Part I. 7500 w. Revue de Mécanique—Feb., 1901. No. 39913 H.

Engines.

Horizontal Steam Engine of 1200 Horse Power (Machine à Vapeur de 1200 Chevaux). Illustrated description of the triple-expansion, poppet-valve engine exhibited at Paris by F. Tosi, of Legnano, Italy. 1200 w. 1 plate. Génie Civil—March 2, 1901. No. 39903 D.

Recent Types of American and European Engines. Illustrates and describes the new engines for the Brooklyn Edison plant, and a Russian engine for electric lighting service. 2500 w. Am Elect'n—March, 1901. No. 39684.

The Westinghouse-Corliss Engine. Illustrates and describes in detail this vertical cross compound engine. 1700 w. Power—March, 1901. No. 39617.

Fly Wheels.

The Strength of Fly Wheels (Festigkeit der Schwungräder). R. Bredt. A mathematical examination into the nature and magnitude of centrifugal stresses and strains on fly wheels, with formulas for safe design. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 23, 1901. No. 39921 D.

See Special Motors.

Fuel.

A New Method of Burning Powdered Fuel. Illustrates and describes the system of William Westlake, which provides a grate upon which a small fire of ordinary coal is maintained. 1500 w. Eng News—March 14, 1901. No. 39790.

See Marine & Naval Engineering.

Heating.

Heating from Central Stations—A Comparison with Private Heating Plants. Alton D. Adams. A statement of the advantages of distributing steam heat from electric stations. 1700 w. Munic Engng—March, 1901. No. 39646 C.

Hot-Water Central Heating in Red Oak, Ia. Illustrated description of a plant with 5,500 ft. of steel mains and 29,000 sq. ft. of radiation, operated to utilize the exhaust steam of an electric station. 1500 w. Eng Rec—March 30, 1901. No. 40080.

Hot Water Heating from Central Stations. Alton D. Adams. Discusses the advantages of such a system, and its efficiency. 2800 w. Elec Wld & Engr—March 23, 1901. No. 40011.

Heating Surface.

The Theory of Ribbed Heating Surface (Zur Theorie der Rippenheizkörper). G. Rothgiesser. An examination of the advantages of using extended or ribbed surfaces for radiators, showing the necessity of providing sufficient thickness of rib to conduct the heat. 1200 w. Gesundheits-Ingenieur—Feb. 28, 1901. No. 39939 B.

Mechanical Draft.

Fuel Combustion with Draft Furnished by Mechanical Methods. W. W. Christie. A critical comparison of the relative advantages of natural and chimney draft, showing the conditions under which either is to be preferred. 3000 w. Engineering Magazine—April, 1901. No. 39967 B.

Mechanical Plant.

Some Engineering Features in the Development of a Country Estate. Illustrated description of the heating, lighting and plumbing on a notable country estate of 600 acres, near New York. 4000 w. Eng Rec—March 16, 1901. No. 39826.

Pipe Covering.

Mica Insulation for Steam Boilers and Pipes. Gives some figures showing the loss of heat in steam boilers and steam pipes, and the results obtained in experiments with various coverings, showing that 90 per cent. is saved by the use of mica insulation. 1600 w. Engng—Feb. 22, 1901. No. 39605 A.

Piston Rings.

Elastic Piston Rings (Selbstspannende Kolbenringe). K. Reinhardt. A mathematical investigation of the forces acting in elastic spring packing rings for steam engine pistons, with tables for practical use and examples of their application. Two articles. 10000 w. Zeitschr d Ver Deutschr Ing—Feb. 16, March 16, 1901. No. 39919 each D.

Steam Power.

Steam Engineering in the United States in 1838. An abstract of a report by the secretary of the treasury containing a census of the stationary, locomotive and marine engines in use up to that time in the U. S. and an account of the accidents in steam plants. 2400 w. Eng Rec—March 16, 1901. No. 39825.

Turbines.

Steam Turbine: Its Development and Use. Abstract of a lecture by Konrad Anderson in the "De Laval Steam Turbine," given at Keighley Institute. 1100 w. Engr, Lond—March 15, 1901. No. 40-040 A.

The Seger Compound Steam Turbine (Turbine à Vapeur Compound). A combination of two disks of the De Laval type, rotating in opposite directions. 1200 w. Génie Civil—March 9, 1901. No. 39-904 D.

Water Gauges.

Glass Tubes for Water Gauges (Wasserstandsröhren und ihre Schutzgläser). O. Schott & M. Herschkowitsch. An account of experimental tests comparing French, English, and Scotch tubes with tubes of the improved Jena glass. 2500 w. Zeitschr d Ver Deutscher Ing—March 9, 1901. No. 39924 D.

MISCELLANY.

Address.

President's Annual Address Before the Engineers' Society of Western Pennsylvania. W. A. Bole. Progress during the century just completed, dealing only with the industrial side. 5500 w. Pro Engs' Soc of W Penn—Jan., 1901. No. 39799 D.

Aeronautics.

The Kress Aeroplane. Brief illustrated account of the invention of W. Kress, a German engineer. 450 w. Sci Am—March 2, 1901. No. 39543.

Agreement.

Philadelphia Molders' and Founders' Agreement. A copy of the agreement between the National Founders' Assn. on behalf of its Philadelphia members, and the Iron Molders' Union of North America, on behalf of its Philadelphia members. 2400 w. Ir Trd Rev—March 7, 1901. No. 39751.

Beet Sugar Works.

The Beet Sugar Industry in Utah. W. P. Hardesty. Illustrates and describes the method of making beet sugar at Lehi, Utah; the seventeen stages of the process are explained and the apparatus briefly described. 5200 w. Eng Rec—March 2, 1901. No. 39633.

Exhibition.

Glasgow International Exhibition. The present article gives an illustrated description of the machinery section, being devoted almost exclusively to the housing provided, but briefly indicating the extent and character of the provision made for power and lighting purposes. 4300 w. Engr, Lond—Feb. 22, 1901. Serial. 1st part. No. 39609 A.

Factory Communities.

Village Communities of the Factory Machine Works, and Mine. C. B. Going. Giving many illustrations of the working out of the practical problems of living connected with new industrial conditions. 4000 w. Engineering Magazine—April, 1901. No. 39964 B.

Heat Losses.

Loss of Heat from Buildings. R. Gordon Mackay. Information collected by the writer concerning the transmission of heat through the various materials commonly used by engineers. 1600 w. Prac Engr—March 8, 1901. Serial. 1st part. No. 39-811 A.

Manufactures.

British Manufactures and the Policy of Unfettered Commerce. Edward Atkinson. An advocacy of free competition in open markets as against a war of tariffs. 5000 w. Engineering Magazine—April, 1901. No. 39961 B.

Organization.

The Organization of Manufacturers. Antonio C. Pessano. Read before the Foundrymen's Ass'n of Philadelphia. Claiming it a necessity to obtain the best results from organized labor, and giving the Philadelphia and New York agreements. 6600 w. Ir Age—March 14, 1901. No. 39756.

Paper Machinery.

Machinery for the Manufacture of Paper (Die Maschinen für Papier-Fabrikation). A. Pfarr. A general description of the paper-making machinery exhibited at the Paris Exposition of 1900. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 16, 1901. No. 39918 D.

Paris Exposition.

The Machinery and Transportation Exhibit at the Paris Exposition of 1900. Prof. Storm Bull. The writer's personal impressions of these exhibits, with remarks by others. 12000 w. Pro W Ry Club—Feb., 1901. No. 39828 C.

Refrigeration.

Cold Storage at the Paris Exhibition. An account of the exhibits, describing the plants. 3000 w. Engr, Lond—March 15, 1901. No. 40037 A.

Russia.

Engineering Opportunities in the Russian Empire. A. H. Ford. An exposition of the vast demands for machinery and for technical skill in the exploitation of the natural wealth of the Russian empire. 3000 w. Engineering Magazine—April, 1901. No. 39963 B.

Tariff.

American Tariff Measures Now Shutting the Open Door. W. L. Saunders. A discussion of the effect of the imposition of the countervailing duty on Russian beet sugar, upon the export of American machinery to Russia. 5000 w. Engineering Magazine—April, 1901. No. 39962 B.

Typesetting.

The Paige Typesetting Machine. Illustrated description of a most complicated piece of mechanism which sets, justifies and distributes foundry types with speed and precision. Also Editorial. 3200 w. Sci Am—March 9, 1901. No. 39685.

Ventilation.

Ventilation and Heating in a Paterson, N. J., Schoolhouse. Illustrated description of the method of ventilating and heating a 24-room school by apparatus occupying a notably small portion of the building's area and contents. 1900 w. Eng Rec—March 9, 1901. No. 39700.

Ventilating and Heating the Boston Music Hall. Illustrated description of plant for a large auditorium heated by direct radiation, using steam from an electric lighting plant; ventilation is secured by a combined plenum and exhaust system, the air entering at the top of the room. 3000 w. Eng Rec—March 2, 1901. No. 39635.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

The Cerrillos Anthracite Mines. Arthur Lakes. Describes a New Mexican coal mine which illustrates the metamorphosis of bituminous into anthracite. 1200 w. Mines & Min—March, 1901. No. 39706 C.

Alabama.

The Warrior Coal Basin. Henry McCalley. From reports of the Alabama Geol. Survey. Describes the basin area and the deposits. 2500 w. Ir & Coal Trds Rev—March 15, 1901. No. 40027 A.

Dust Prevention.

Apparatus for Laying Coal Dust (Einrichtungen zur Unschädlichmachung des Kohlenstaubes). H. Winkhaus. An examination of the cost of installing sprinkling apparatus in the mines of the Cologne Mining Company at Altenessen. 2500 w. Glückauf—March 2, 1901. No. 39937 B.

France.

Present Condition of the Coal Market in France. Discusses the question of reducing the cost of ocean transportation of coal so as to enable the United States to compete with Gt. Britain in supplying European markets. 1200 w. U. S. Cons Repts, No. 994—March 26, 1901. No. 40016 D.

Iowa.

An Iowa Coal Mine. Illustrated description of mine known as Cleveland No. 4. 900 w. Eng & Min Jour—March 23, 1901. No. 40015.

Appanoose County Coal Field. J. J. Rutledge. A description of the coal, the methods of mining and the use of machines in thin veins. 2600 w. Mines & Min—March, 1901. No. 39708 C.

Mexico.

Las Esperanzas Coal Mines, Mexico. Edwin Ludlow. Illustrated description of mines and coke oven plants. 1000 w. Eng & Min Jour—March 16, 1901. No. 39830.

New Mexico.

A New Coal Field in Northwestern New Mexico. Arthur Lakes. An account of an exploring expedition in a comparatively unknown region. Ill. 2500 w. Mines & Min—March, 1901. No. 39714 C.

Ohio.

Names for the Formations of the Ohio Coal-Measures. Charles S. Prosser. Reviews the formations of Ohio, showing that their limits correspond to those of Pennsylvania, and proposing that the same names be used. 2500 w. Am Jour of Sci—March, 1901. No. 39644 D.

Pittsburg.

Beginning and Development of Pittsburg's Coal Industry. Edgar W. Hassler. Brief review of the early history of this important industry. 2000 w. Am Mfr—March 7, 1901. No. 39689.

Pumps.

The Pumping and Spraying Arrangements at a Bohemian Colliery. A. Padour, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Illustrated description of Riedler pumping engines and spraying devices to keep the mines cool. 2000 w. Col Guard—Feb. 22, 1901. No. 39614 A.

Shropshire.

The Unconformity in the Coal Measures of the Shropshire Coalfields. William James Clarke. Illustrated description of the positions of the beds, with explanations regarding them. 3000 w. Col Guard —Feb. 22, 1901. No. 39616 A.

Thin Seams.

The Working of Thin Coal Seams. Information from the presidential address of John Gerrard, before the Midland Inst. of Mining, Civil & Mech. Engs., showing the extent to which these seams are being worked in Great Britain. 1300 w. Col Guard—March 8, 1901. No. 39805 A.

Vancouver.

Coal Mining on Vancouver Island. An account, with illustrations, of the three collieries worked last year. 1100 w. Col Guard—March 1, 1901. No. 39727 A.

Windber.

The Windber Mine. J. S. Cunningham. Read before the Western Penn. Cen. Min. Inst. Plan of mine with description of underground haulage and mining methods as installed and used at Windber, Pa. 1800 w. Mines & Min—March, 1901. No. 39705 C.

COPPER.

Leaching.

Leaching Copper Ores by Sulphurous Acid. E. P. Jennings. Read before the Canadian Min. Inst. Describes the process patented in the United States by James W. Neill, suitable both for sulphide and oxidized ores, the former being first roasted to expel the sulphur and convert the copper compounds into oxides. 900 w. Can Min Rev—Feb. 28, 1901. No. 39669 B.

Wyoming.

Wyoming Copper Fields. Grant Jones. A résumé of the southern Wyoming copper fields and their development. Ill. 5800 w. Ores & Metals—March, 1901. No. 39793.

GOLD AND SILVER.

Analysis.

Analysis of Chloridized Ores. P. J. Thibault. Deals with a method of proximate analysis of chloridized ores, which are free from arsenic, antimony and lime. 3200 w. Aust Min Stand—Jan. 31, 1901. No. 40005 B.

Australia.

Gold Mining and Milling in Western Australia. A. G. Charleton. Mr. Charleton's third paper deals with the water problems of the region, and the manner in which they have been solved. 4000 w. Engineering Magazine—April, 1901. No. 39968 B.

Cape Nome.

Notes on Nome, and the Outlook for Vein Mining in that District. Forbes Rickard. The writer's opinion concerning the gold deposits, their origin, etc. 2000 w. Eng & Min Jour—March 2, 1901. No. 39567.

Chlorination.

Chlorination Mills at Cripple Creek, Colorado. Arthur Lakes. Illustrated description of the methods used in handling the ore and the application of the process. 2800 w. Mines & Min—March, 1901. No. 39704 C.

Cyanide Process.

Notes on the Assay of the Zincy Precipitates Obtained in the Cyanide Process. Charles H. Fulton and Charles H. Crawford. Describes work performed in the endeavor to evolve a short and accurate method which can be used in a custom assay office or mill. Tabulated information of assays made is given. 2700 w. Sch of Mines Quar—Jan., 1901. No. 39769 D.

Siemens-Halske Cyanide Process. John B. C. Kershaw. A review of this electrochemical process and its degree of success. Considers that neither the anodes nor the cathodes answer the requirements of a perfectly satisfactory process. 1500 w. Aust Min Stand—Jan. 24, 1901. No. 39539 B.

Extraction.

Electrolytic Processes for Gold Extraction. Alfred T. Weightman. Some of the methods which have been proposed are discussed and the difficulties met in their operation. 2200 w. Mines & Min—March, 1901. No. 39712 C.

Gold Milling.

Notes on Gold Milling Practice at the Athabasca Mine, Nelson, B. C. E. Nelson Fell. Read before the Canadian Min. Inst. Of interest because of the peculiar character of the ore treated. The general features are a hard blueish quartz, containing a large proportion of sulphides of zinc, lead and iron, showing free gold only when the ore is of fair grade. 2500 w. Can Min Rev—Feb. 28, 1901. No. 39668 B.

Mexico.

Mining Camps Near Topia, Durango, Mexico. Frank B. Fowler. Brief accounts of Canelas, Birimoa, Guaysimillas, La Bajada, Tamazula, etc., worked principally for the gold and silver deposits. 1200 w. Eng & Min Jour—March 16, 1901. Serial. 1st part. No. 39832.

Queensland.

Mining in Queensland. Donald Clark. Discusses the treatment of auriferous ores in various places. The present article considers Charters Towers. 1600 w. Aust Min Stand—Feb. 14, 1901. Serial. 1st part. No. 40008 B.

Similkameen River.

The Great Lower Similkameen. An account of important deposits of gold, silver, iron and copper in British Columbia, Reviewing briefly the mining history of the district. 2800 w. B. C. Min Rec—March, 1901. No. 39862 B.

Slimes.

Saving Slimes. W. C. Clark. An account of experiments in the recovery of valves which have gone to waste in tailings from concentrators of lead-silver ores. 1800 w. Mines & Min—March, 1901. No. 39707 C.

Tailings.

The Treatment of Highly Acidic Tailings by the Cyanide Process. F. B. Stevens. An account of difficulties encountered in treating the large heaps of accumulated tailings of the Transvaal goldfields. 1700 w. N. Z. Mines Rec—Jan. 16, 1901. No. 39628 B.

Telluride.

Telluride Ores. T. A. Rickard. Concerning the treatment of these ores at Cripple Creek and Kalgoorlie. 3000 w. Aust Min Stand—Jan. 31, and Feb. 7, 1901. No. 40004, 2 parts, each B.

Transvaal.

Taxes and Labor in Transvaal Mines. From the London *Economist*. Discusses the prospect of reducing working costs in the gold mines. 1700 w. Eng & Min Jour —March 16, 1901. No. 39831.

IRON AND STEEL.

Blast Furnace.

American Steel and Wire Company's New Blast Furnace at Neville Island. Christian Larsen. An illustrated description of a modern blast furnace plant being erected near Pittsburg, with a capacity greater than any furnace in existence. 1800 w. Am Mfr—Feb. 28, 1901. No. 39627.

A Modern American Blast Furnace—Its Construction and Equipment. Arthur C. Johnston. Describes the construction of a modern furnace, its equipment and the appliances for concentrating and handling the enormous amount of material required, drawing conclusions based on the operation. Ill. 7 plates. 4700 w. Jour Assn of Engng Socs—Jan., 1901. No. 39579 C.

Grading.

Erratic and Systematic Grading of Pig Iron by Analysis. Thomas D. West. A discussion of the methods adopted in grading pig iron by analysis with suggestions aiming to bring about uniformity. 1600 w. Jour Am Found Assn—March, 1901. No. 39585.

Iron Sand.

Notes on the Magnetic Iron Sand of the North Shore of the St. Lawrence. J. Obalski. Read before the Canadian Min. Inst. Historical sketch of the attempts to work these deposits profitably, and a study of their character. 2200 w. Can Min Rev—Feb. 28, 1901. No. 39667 B.

Rolling Mills.

Some Landmarks in the History of the Rolling Mill. Charles H. Morgan. Retiring presidential address before the Am. Soc. of Mech. Engs., Dec. 4, 1900. Historical review of its development, showing the important effect it has had on the material welfare of the country. Ill. 1100 w. Jour Worcester Poly Inst—March, 1901. No. 39842 C.

Separation.

Some Applications of the Wetherill Process of Magnetic Separation of Iron Ores. An abstract translation of a paper read at the Paris Exposition, by M. Smits, describing this process. 1500 w. Eng & Min Jour—March 30, 1901. No. 40085.

Steel.

A. J. Moxham on Steel Making in Canada. Address before the Canadian Mfrs' Assn. On Canada's advantages in steelmaking. 4400 w. Ir Trd Rev—Feb. 28, 1901. No. 39549.

Steel Billets.

The History of the 4-Inch Steel Billet in the United States. William Garrett. 3200 w. Ir & Coal Trds Rev—March 8, 1901. No. 39814 A.

Steel Trust.

American Trusts and British Industries. States the problem and discusses the purposes of trusts, the management, and methods of organized industry, etc. Also editorial. 4000 w. Ir & Coal Trds Rev—March 1, 1901. Serial. 1st part. No. 39-729 A.

The Great Steel Trust. Editorial discussion of the great consolidation recently consummated in the United States. 1200 w. Engr, Lond—March 8, 1901. No. 39809 A.

The United States Steel Corporation. Editorial discussion of this vast consolidation and the effect on many industries. 2000 w. Eng News—March 7, 1901. No. 39672.

Sweden.

Some of the Iron and Steel Industries of Sweden. Robert W. Hunt. A lecture delivered before Sibley College. Briefly reviews the history of this important industry and describes visits paid to a few of the mines and works. 6500 w. Sib

Jour of Engng—March, 1901. No. 39844 C.

MINING.

Ancient Mines.

Ancient Miners of Lake Superior. Information concerning the traces of a race which antedates the memory of the Indians, and of their workings, and their familiarity with the copper deposits. 3800 w. Marine Rev—March 14, 1901. No. 39836.

Boring.

Boring Rods (Ueber die Bohrstange). W. Wolski. An examination of the dimensions and strength of rods for making deep bore holes. 2000 w. Glückauf—March 9, 1901. No. 39938 B.

British Columbia.

Mining Practice at Rossland, British Columbia. R. B. Brinsmade. Illustrates and describes the methods of development at War Eagle and Centre Star. The diamond drilling, shaft sinking, drifting, raising, blasting, trimming, hoisting, ventilation, lighting, pumping, air compression, etc., and costs. 6000 w. Mines & Min—March, 1901. No. 39711 C.

Dams.

Erection of Mine Dams at Pribram. Illustrated description of novel methods and the results attained in Bohemia. 900 w. Col Guard—March 15, 1901. No. 40029 A.

Dam Construction in the Mines at Pribram, Bohemia (Verdämmungsbauten beim Pribramer Hauptwerke). F. Mladek. With illustrations of wooden and masonry dams used in closing mining tunnels against water. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 2, 1901. No. 39936 B.

Mine Dams. James MacNaughton. Read before the Lake Superior Mining Inst. An interesting description of dam construction in Chapin Mine. Ill. 2100 w. Eng News—March 21, 1901. No. 39860.

Explosive Gas.

Explosive Gas in a Metalliferous Mine. Read before the Inst. of Min. & Met., London. F. W. Grey. Notes on an unusual occurrence observed in the Hutti mine in India, while undertaking the development of old native gold workings. 1400 w. Col Guard—March 1, 1901. No. 39728 A.

Explosives.

A Brief Sketch of the Essential Requisites of "Powder" as Distinguished from "Explosives." Dr. W. J. Williams. Address of the retiring president setting forth the requirements of a powder and of an explosive. 3800 w. Jour Fr Inst—March, 1901. No. 39642 D.

The Ignition of Explosives. A discussion of the advantages and costs of the various methods. 2100 w. Col Guard—March 8, 1901. No. 39804 A.

Exposition.

Mining Material at the Exposition of 1900 (Exposition Universelle de Paris 1900. Le Matériel des Mines). A. Habets. The first instalment of a description of boring, drilling, cutting, hoisting, and other mining appliances exhibited at Paris. Serial. Part I. 7000 w. 3 plates. Rev Univ des Mines—Feb., 1901. No. 39914 F.

Fans.

The Guibal Ventilating Fan. Fan described by John W. Robinson, in the *Journal* of the British Soc. of Min. Students, with the result of experiments. Ill. 1200 w. Col Guard—March 15, 1901. No. 40031 A.

Mining Plant.

See Electrical Engineering, Power Applications.

Mine Transmission.

See Electrical Engineering, Transmission.

Mining.

Mining. A. J. Bensusan. On the general subject of mining, discussing prospecting, exploration, exploitation, metallurgical treatment, etc. 3600 w. Aust Min Stand—Feb. 7, 1901. No. 40006 B.

Paris Exposition.

Mining at the Paris Exposition. David T. Day. A lecture before the Museum of Natural Hist., New York City. Describes the peculiar features of the industry as there illustrated. 1300 w. Mines & Min—March, 1901. No. 39709 C.

Pennsylvania.

Graphite and Garnet Industries in Pennsylvania. T. C. Hopkins. Tells where the minerals occur, the uses to which they are put, and their values. 1700 w. Mines & Min—March, 1901. No. 39710 C.

Power Cost.

What Is the Cost of a Horse-Power at a Colliery? Sidney F. Walker. Condensed from the *Jour. of the British Soc. of Min. Students.* Thinks the best method is to make a first approximation by calculation and then correct it by means of electric motors. 4200 w. Ir & Coal Trds Rev—March 15, 1901. No. 40026 A.

Russia.

Mining and Metallurgy in Central Russia in 1900 (Les Mines et la Métallurgie dans le Midi de la Russie en 1900). A. Spilberg. An exhaustive report prepared for the 25th Russian Mining Congress, dealing especially with coal and iron of Central Russia. 9000 w. Rev Univ des Mines—Feb., 1901. No. 39915 F.

Stamps.

Power Required by Stamps. A. W. Warwick. Calculations for determining this power, showing that the not taking into account of the inertia factor has been the cause of discrepancy between the calculated and actual power required by the stamp head. 2500 w. Min & Sci Pr—Feb. 23, 1901. No. 39542.

Stamp Mill Steam Practice. A. W. Warwick. Remarks on the power plants of 5 and 10-stamp mills, and the increase of cost due to lack of care in design or in running the steam plant of a stamp mill. 2000 w. Min & Sci Pr—March 2, 1901. No. 39681.

Timbering.

Mine Timbering (Holzmauerungen in der Grube). A. Hübner. Discussing especially the construction of partitions for the control of ventilation and the isolation of gaseous workings. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 2, 1901. No. 39935 B.

Wooden Structures in Colliery Workings. A. Hübner, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Illustrates and describes those successfully employed in the fiery pits of Northern Bohemia. 1000 w. Col Guard—March 15, 1901. No. 40030 A.

MISCELLANY.

Law.

Dutch East Indian Mining Law. A translation of the mining law of the Netherlands East Indies. 4000 w. Aust Min Stand—Feb. 14, 1901. Serial. 1st part. No. 40007 B.

Lead.

Lead Refining in Canada. Discusses the reasons for the backwardness in smelting and the absence of lead refining plants in Canada, and gives a statement of present conditions. 2000 w. Can Min Rev—Feb. 28, 1901. No. 39665 B.

Petroleum.

Notes on Petroleum in California. E. W. Claypole. The location of the fields and the advantages from the use of this product; also the geology and the future outlook. 3800 w. Am Geol—March, 1901. No. 39810 D.

Petroleum as a Fuel for Metallurgical Furnaces. A. V. Forselles, in *Technisk Tidskrift.* Information regarding its use in Russia, and the method of burning it. Ill. 1800 w. Gol Guard—Feb. 22, 1901. No. 39615 A.

Petroleum in the United States. J. Ohly. Analysis of the Denver oil basin, giving Moissan's theory and information of the output, and other matters. 3800 w. Ores & Metals—March, 1891. No. 39794.

The Coalinga Oil Field, California. W. G. Young. A brief account of a district south of the center of the state. 800 w. Eng & Min Jour—March 30, 1901. No. 40087.

Ural Mountains.

Minerals in the Ural Mountains. Information concerning the mineral deposits and the efforts being made by Russia to interest foreign capital in the mines. 800 w. U. S. Cons Repts, No. 975—March 2, 1901. No. 39586 D.

RAILWAYS AND TRAMWAYS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in January. Detailed list and classified summary. 5000 w. R R Gaz—March 1, 1901. No. 39560.

Dispatching.

Economic Train Dispatching. G. W. Turner. Read before the Pacific Coast Ry. Club. Discusses the subject generally, criticizing some features of present practice. 1500 w. Ry & Engng Rev—March 23, 1901. No. 40061.

Economical Handling.

Further Economies of Coal and Ore Handling. John M. Goodwin. Illustrates and describes the method patented by the writer. 1000 w. R R Gaz—March 1, 1901. No. 39559.

India.

Railways and Famine. Horace Bell. Questions whether railways, making accessible foreign markets, do not lead to too large exportation of products in time of plenty, and so in some measure cause famines. Considers conditions in India, but applicable to other countries. Discussion. 12000 w. Jour Soc of Arts—March 15, 1901. No. 40020 A.

Interurban.

Cleveland & Eastern Interurban Line. Illustrated description of this line, the sixth to be built with Cleveland as one of the termini. 1400 w. St Ry Rev—March 15, 1901. No. 39837 C.

Japan.

Japan and Its Transportation Facilities. Willard C. Tyler. An interesting address giving an account of the country, the older forms of transportation, the railroads and the steamship lines; with addresses also from Col. Joseph U. Crawford and Mr. S. Uchida, the consular representative.

14000 w. N Y R R Club—Feb. 21, 1901. No. 39795.

Transportation.

The Personnel, Material and Methods of a Railroad. L. F. Loree. An address before the Assn. of Transportation Officers, full of practical suggestions. 2000 w. R R Gaz—March 8, 1901. No. 39733.

Travelling.

Some Features of Railway Travelling, Past and Present. Frederick McDermott. Presents features showing the growth and progress, and gives facts of interest concerning early methods of conducting transportation. General discussion. 8500 w. Jour Soc of Arts—Feb. 22, 1901. No. 39593 A.

Underground.

The Metropolitan Railway of Paris (Le Metropolitain de Paris). A. Dumas. A fully illustrated account of the portion of the line already constructed, and of the power house, and a description of the experience in its operation. Two articles. 12000 w. 2 plates. Génie Civil—March 2, 9, 1901. No. 39902 each D.

Wrecks.

Some Recent Notable Train Wrecks. Reports briefly some recent wrecks, showing the strength of steel cars, and reporting strange accidents. 700 w. Eng News —March 14, 1901. No. 39789.

FINANCIAL.

Cost Comparison.

A Comparison of Costs in Iron Ore Handling and Transportation. Waldon Fawcett. Discusses the volume of ore shipments and the expenditure by lake and rail. 3000 w. Ir Age—March 21, 1901. No. 39818.

MOTIVE POWER AND EQUIPMENT.

Boston Elevated.

New Power Station and Elevated Railway System in Boston. Illustrated detailed description of the system of elevated, surface and subway tracks, and the power station, car house, etc. 4500 w. St Ry Jour—March 2, 1901. No. 39655 D.

Brake.

The Price Patent Friction Brake. Illustrated description of a tramcar brake devised to overcome the disadvantages usually found in the ordinary hand-ratchet brake. 1000 w. Elec Rev, Lond—Feb. 22, 1901. No. 39600 A.

Car Building.

Modern Car Building. An illustrated description of G. F. Milnes and Company's works at Hadley. 2600 w. Tram & Ry Wld—March 7, 1901. No. 40065 A.

Car Hoods.

Street Car Hoods or Canopies. W. E. Partridge. Illustrates and describes the Various forms in common use, discussing the designs. Also considers steam car hoods. 4300 w. St Ry Jour—March 2, 1901. No. 39657 D.

Coal Handling.

Handling Locomotive Coal on the New York Central. Brief illustrated description of the coaling and sanding station at Syracuse, and the coal storage plant at DeWitt. 700 w. R R Gaz—March 8, 1901. No. 39744.

Darwen.

Darwen Electric Tramways and Refuse Destructor. Illustrated description of a tramway installation at Darwen, England, in which steam is raised by refuse destructors. 5000 w. Tram & Ry Wld—Feb. 7, 1901. No. 39562 A.

Locomotives.

Compound Consolidation Freight Locomotives with Wide Firebox. Illustration and particulars of a new locomotive for the N. Y. C. & H. R. R. R., known as the "Central Consolidation." It is a two-cylinder compound, with a wide grate, large boiler and 210-lb. boiler pressure. 800 w. Am Engr & R R Jour—March, 1901. No. 39552 C.

Culm-Burning Switching Locomotives. Side elevation and general dimensions of engine for the D., L. & W. R. R. 350 w. Am Engr & R R Jour—March, 1901. No. 39554 C.

Express Locomotives at the Paris Exposition, 1900 (Die Schnellzug-Locomotiven auf der Weltausstellung in Paris 1900). C. Schlöss. With tabular view giving classified arrangement of exhibited locomotives. Serial. Part I. 3500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—March 15, 1901. No. 39930 B.

Express Locomotive for the Prussian State Railways (Locomotive à Grande Vitesse des Chemins de Fer de l'Etat Prussien). A. Morizot. Illustrated description of engine with the Schmidt superheater exhibited at Paris by Borsig of Berlin. 1200 w. Revue Technique—Feb. 25, 1901. No. 39906 D.

German Four-Cylinder Compound. Illustrated description of eight-wheel compound exhibited at Paris by the Hanover Construction Company. 600 w. Loc Engng—March, 1901. No. 39648 C.

Most Powerful Express Locomotive in the World. Illustration with description of an engine for the New York Central & Hudson River R. R., of the Atlantic type. The primary object was to provide a huge boiler with sufficient capacity to furnish a plentiful supply of steam at 200 pounds pressure under the most exacting conditions of service. 1000 w. Sci Am—March 16, 1901. No. 39774.

Ratios of Total Weight to Heating Surface in Recent Locomotives. Gives the proportions recommended by the Master Mechanics' Assn. in 1897, with remarks on this subject. 700 w. Am Engr & R R Jour—March, 1901. No. 39553 C.

Schenectady Ten Wheel Locomotive for Cape Government Railways. Illustrated description of a ten-wheel narrow-gage engine. 700 w. Loc Engng—March, 1901. No. 39649 C.

Swiss Locomotives at the Exposition of 1900 (Les Locomotives Suisses à l'Exposition de 1900). R. Godfernaux. General description, with illustrations of the engines exhibited by the Winterthur locomotive works. 3500 w. 4 plates. Rev Gen de Chemins de Fer—Feb., 1901. No. 39911 H.

Tank Locomotive for the South-Eastern and Chatham Railway. Illustration, particulars and dimensions. 900 w. Engng—March 15, 1901. No. 40033 A.

The New Class "J" Passenger Locomotive of the Lake Shore & Michigan Southern Railway. Illustrated description of a new engine for heavy and fast passenger service. 2700 w. Am Engr & R R Jour—March, 1901. No. 39550 C.

Two-Cylinder Compound Consolidation Locomotives, Class G-1—New York Central Railroad. Illustrated description of engine designed for heavy freight service, but so equipped that they may be used in emergency on passenger trains. 55 of these engines have been ordered. 700 w. R R Gaz—March 1, 1901. No. 39557.

Ore Cars.

New 100,000-lb. Capacity Wooden Ore Cars—Chicago, Milwaukee & St. Paul Ry. Illustrated description. 500 w. R R Gaz—March 1, 1901. No. 39558.

Polyphase.

Polyphase Electric Traction. C. A. Carus-Wilson. Calls attention to some features of the polyphase system, particularly relating to punctuality and frequency of train service, that make it of great advantage; and gives an illustrated detailed description of the Burgdorf-Thun Ry. in Switzerland. 6000 w. Tram & Ry Wld—Feb. 7, 1901. No. 39563 A.

Storage Batteries.

On the Use of Storage Batteries in Connection with Electric Tramways. G. A. Grindle. Abstract of paper read before the Inst. of Elec. Engs. (Manchester). Briefly refers to the application of batteries to electric traction, and discusses the advantages by including a battery in the power system. 2200 w. Elec Rev, Lond—March 8, 1901. Serial. 1st part. No. 39803 A.

Surface Contact.

Surface Contact Systems of Electric Traction. An illustrated review of the various systems of surface contact and conduits. 3000 w. Prac Engr—March 1, 1901. Serial. 1st part. No. 39723 A.

Trucks.

Four-Wheel Passenger Truck of the Chicago, Burlington & Quincy. Illustrated description of the latest design for this road, to be used under cars weighing from 80,000 to 85,000 lbs. 500 w. R R Gaz—March 15, 1901. No. 39797.

NEW PROJECTS.

Great Salt Lake.

A Railroad Through Great Salt Lake. Kenneth C. Kerr. An illustrated account of a proposed change on the Southern Pacific, building a line across the lake from Ogden to Lucin, thus eliminating long, expensive grades, and reducing the distance and curvature. 1200 w. Ry Age (Spe. No.)—March 15, 1901. No. 39882 D.

St. Petersburg.

The Projected Metropolitan Railway for St. Petersburg. A summary of the project taken from the *Gazette du Commerce et de l'Industrie.* It is proposed to construct a "Ring Railway," and also several lines in different quarters, with a large central station as a general junction. 1100 w. Engr, Lond—March 15, 1901. No. 40038 A.

PERMANENT WAY AND BUILDINGS.

Albany, N. Y.

The Albany Improvement on the New York Central. An illustrated account giving a general idea of the conditions overcome and the methods of prosecuting the work, which involved an expenditure of nearly two million dollars. 6000 w. Ry & Engng Rev—March 16, 1901. No. 39897.

Ballasting.

Ballasting. Report of the Com. of the Am. Ry Engng & Main. of Way Assn. with discussion. 3000 w. Ry Age (Spe. No.)—March 15, 1901. No. 39888 D.

Cardiff.

Electric Tramways in Cardiff. An outline from a local paper describing the undertaking. 900 w. U. S. Cons Repts, No. 973—Feb. 28, 1901. No. 39546 D.

Car Shops.

New Car Shops at Readville, Mass.—New York, New Haven & Hartford R. R. Engravings, illustrating the chief details of the buildings, except the power house, with description. 1500 w. Am Engr & R R Jour—March, 1901. No. 39551 C.

Conduit.

A New Slotted Conduit. A conduit designed with the object of reducing the cost necessary in the open slot conduit due to the depth of excavation required. Ill. 1500 w. Elec Rev, Lond—March 1, 1901. No. 39691 A.

Construction.

Heavy Railway Construction in Wyoming. J. I. Boggs. An illustrated description of work on the Union Pacific Railroad to reduce grades and straighten alignments. The description is confined to the heaviest part of the work on the Second Division, extending over four miles. 5000 w. Pro Am Soc of Civ Engs —Feb., 1901. No. 39580 E.

Culverts.

Rail Top Culverts. Albert Reichmann. Illustrates and describes the class of culverts built by the Chicago, Milwaukee & St. Paul Ry. Co. Discussion. 2700 w. Jour W Soc of Engs—Feb., 1901. No. 39766 D.

Electrolysis.

See Civil Engineering, Water Supply.

Freight Yards.

Freight Yards of the Chicago Transfer & Clearing Company. Plans and description of the largest railroad yard in the world, now building at Chicago. 1200 w. R R Gaz—March 8, 1901. No. 39738.

Graduation.

Graduation. The term as here used embraces the preparation of the ground, the excavation and placing of the material, and other general work incident to the formation and maintenance of the railway roadbed and yards. Report of the Committee of the Am. Ry. Engng. & Main. of Way Assn. With discussion. 9200 w. Ry Age (Spe. No.)—March 15, 1901. No. 39884 D.

Huddersfield.

Huddersfield Corporation Tramways. Reviews the history of these tramways and illustrates and describes the new equipment made necessary by the change from steam to electric traction. 6000 w. Tram & Ry Wld—March 7, 1901. No 40063 A.

Lisbon.

The Street Railway System of Lisbon. F. A. Wardlaw. An illustrated description of the street railways of this beautiful city of Portugal, the difficulties encountered, and novel features in construction and equipment introduced in changing to electricity. 5000 w. St Ry Jour—March 2, 1901. No. 39659 D.

London.

London County Council Slot Electric Tramways. Illustrated description of the conduit system proposed, noting the essential features. 3000 w. Engr, Lond—Feb. 22, 1901. No. 39610 A.

The London County Council and Electric Tramways. Discusses briefly the general aspect of the question of electrical traction in London, and gives an illustrated description of the conduit system devised by A. B. W. Kennedy. 2500 w. Engng—Feb. 22, 1901. No. 39606 A.

The Proposed Electric Conduit for the London County Council's Tramways. Illustrated description of the electric conduit which has been devised for use on the routes between Westminster Bridge and Tooting, and other routes. 1800 w. Elect'n, Lond—Feb. 22, 1901. No. 39596 A.

The Proposed Electric Conduit System of the London County Council. Illustrated description, with special reference to designs adopted in other cities. 4200 w. Tram & Ry Wld—March 7, 1901. No. 40064 A.

London's First Electric Tramway. Frederick A. Talbot. An account of the great opposition encountered, and an illustrated description of the line and its equipment. 2200 w. St Ry Jour—March 2, 1901. No. 39660 D.

Monorail.

The Proposed High-Speed Electrical "Monorail" Between Liverpool and Manchester. F. B. Behr. Describes the system and claims that it possesses the advantages of cheapness and safety as well as its adaptability for high-speed passenger traffic. 7800 w. Jour Soc of Arts—March 15, 1901. No. 40021 A.

N. Y. Central.

New York Central's Standard Engineering. Illustrated description of improvements of importance now being executed. 5500 w. Ry Age (Spe. No.)—March 15, 1901. No. 39883 D.

The Engineering Department of the New York Central. A general outline of the immense work done by this department and the problems to be solved, and an account of recent changes of grade and line. Ill. 4800 w. R R Gaz—March 8, 1901. No. 39736.

Nottingham.

Nottingham City Tramways. Illustrated detailed description of the construction of the new overhead electric line. 3700 w. Tram & Ry Wld—Feb. 7, 1901. No. 39561 A.

Victoria Station, Nottingham, England. Description and illustrations of a fine station opened for traffic about one year ago. 1500 w. Ry Age (Spe. No.)—March 15, 1901. No. 39885 D.

Oiled Roadbed.

The Oiled Roadbed on the Long Island Railroad. C. L. Addison. A brief statement of conditions previous to the application and the success and cost. 700 w. R R Gaz—March 8, 1901. No. 39735.

Oil House.

A Model Oil House—Chicago and Northwestern Railway. Illustrated detailed description of this part of the plant at Clinton, Iowa. 600 w. Ry Mas Mech —March, 1901. No. 39715.

Paris.

The Prolongation of the Orleans Railway to the Quai d'Orsay (Prolongement de la Ligne d'Orleans au Quai d'Orsay). H. de la Brosse. Describing especially the difficult underpinning and supporting of buildings in running the line under the heart of Paris. 4500 w. 2 plates. Rev Gen de Chemins de Fer—Feb., 1901. No. 39910 H.

Rail Bond.

Apparatus for Determining the Conductivity of Rail Bonds (Appareil pour Déterminer la Conductance des Joints de Rails). J. A. Montpellier. A description of the Siemens & Halske device, by which the conductivity of the joint is compared with that of the solid rail. 1200 w. Electricien—Feb. 16, 1901. No. 39932 B.

Rails.

How to Study the History of a Rail. Stephen W. Baldwin. Suggests a method for measuring wear of rails and of reports to be required of inspectors. 800 w. R R Gaz—March 8, 1901. No. 39746.

Notes on Some of the Recent Discussions on Rails. Editorial on points brought out in recent papers, with a list of articles on rails which have appeared in this paper during the last 14 months. 1200 w. R R Gaz—March 8, 1901. No. 39747.

Specification for Steel Rails. P. H. Dudley. Discusses the conclusions adopted by the British Board of Trade, and the conditions and practice in the United States. 2000 w. R R Gaz—March 8, 1901. No. 39737.

The Quality of Steel for Rails. Notes from some of the reports presented at Paris, in Sept., 1900, in regard to foreign experience and practice. 1800 w. Eng News—March 7, 1901. No. 39674.

Roadbed.

Roadbed Improvements on the Union Pacific. An outline of the heavy construction work in progress, and the engineering features, with descriptions and illustrations of methods of work. 2100 w. Ry & Eng Rev—March 16, 1901. No. 39893.

San Francisco.

Some Recent Electric Railway Construction for San Francisco. S. L. Foster. Illustrated account of features introduced in changing from cable, steam and horse power to electricity. 5800 w. St Ry Jour—March 2, 1901. No. 39656 D.

Signals.

Automatic Electric Block Signal System of the Southern Hungarian Railway (Elektro-Automatische Blocksignal anlage der Ungarischen Sudbahn). O. Ehrenfest. With photographs of the apparatus and plans of the system of connections. 3000 w. Elektrotech Zeitschr—March 7, 1901. No. 39955 B.

Interlocking at the Grand Central Station, New York. Illustrates and describes the system of pneumatic interlocking and its working, giving a statement of the conditions to be met. 1800 w. Ry Age (Spe No.)—March 15, 1901. No. 39886 D.

Low-Pressure Pneumatic Interlocking. C. & W. I. R. R., 16th Street Subway, Chicago. Illustrated description of a recently installed plant. 2300 w. Ry & Engng Rev—March 16, 1901. No. 39899.

Taylor Electric Interlocking at West Chicago, Ill. Illustrates and describes an interesting recent installation for signalling and interlocking, all the movements being controlled by electricity. 1600 w. Ry & Engng—March 16, 1901. No. 39894.

Third Rail.

Third Rail in the Baltimore Belt Line Tunnel. An illustrated description of the sectional and third-rail installations with which this line has been recently equipped. 1400 w. Sci Am—March 16, 1901. No. 39776.

Ties.

Decay of Ties and Bridge Timber. Dr. Hermann von Schrenk. Presented at the Am. Ry. Engng. & Main. of Way Assn. Gives results of recent work, the methods hitherto adopted to prevent such decay, with recommendations as to what ought to be done in the future. 2500 w. Ry Age (Spe. No.)—March 15, 1901. No. 39881 D.

Preservation of Sleepers in England and Continental Countries. P. H. Dudley. A brief account of handling and treating sleepers by the London & North Western at Willesdon Junction, near London; and the treatment on the Belgian railroads, with illustrations of woods after years of service. 3500 w. R R Gaz—March 8, 1901. No. 39743.

Ties. The subject is divided into 8 subheads discussed by members of the Com. of the Am. Ry. Engng. & Main. of Way Assn. and discussed. 10500 w. Ry Age (Spe. No.)—March 15, 1901. No. 39892 D.

Tracks.

Track. Report of Com. of Am. Ry. Engng. & Main. of Way Assn. Individual expressions of the members of the committee, with discussion. 22800 w. Ry Age (Spe. No.)—March 15, 1901. No. 39890 D.

Uniform Track Structure. M. W. Thomson. Reviews the changes made necessary by changed conditions, and the experience with angle bars on the Pennsylvania tracks. 2200 w. R R Gaz—March 8, 1901. No. 39741.

Tunnel.

The New Street Railway Tunnel Under

Boston Harbor. J. A. Stewart. Illustrated description of interesting engineering work costing about $2,700,000. 1200 w. Sci Am—March 23, 1901 No. 39853.

Tunnels on the West Virginia Short Line Railroad. J. V. Davies. Describes this line through a very mountainous region, and illustrates and describes the extensive tunnel construction. 2800 w. R R Gaz—March 8, 1901. No. 39739.

Ventilation of the East Mahanoy Tunnel—Philadelphia & Reading. Theodore Voorhees. Illustrated description of a fan installation where advantage was taken of part of the working of the Buck Mountain coal vein, which is cut by the tunnel. 1100 w. R R Gaz—March 8, 1901. No. 39734.

Turntable.

Turntable Operation with Gasoline Engine. Illustrated description of an installation for the N. Y. C. & H. R. R. R. in New York City. 400 w. Ry & Engng Rev—March 16, 1901. No. 39898.

Water.

Water Service. Report of Com. of the Am. Ry. Engng. & Main. of Way Assn. Reports of three sub-committees considering the source of supply, method of pumping, and character of water, with discussion. 7200 w. Ry Age (Spe. No.) —March 15, 1901. No. 39891 D.

Yards.

Certain Considerations in Designing Yards. W. L. Derr. Suggestions concerning the arrangements in yards and the circumstances that should be considered in determining the yard design. 1200 w. R R Gaz—March 8, 1901. No. 39740.

The New Yard at the Grand Central Station. Plan and description of the recent rearrangement and improvements. 2300 w. R R Gaz—March 22, 1901. No. 39870.

The Re-design of Freight Yards. Shows the importance of the yard problem and discusses briefly yards well and poorly designed. 2100 w. R R Gaz—March 22, 1901. No. 39869.

The Setting Out of Yard Tracks. Particulars in regard to methods adopted in different yards, with remarks on the advantages and points needing care. Ill. 2600 w. Eng News—March 28, 1901. No. 40055.

Yard Design Regarded as a Switching Machine for Sorting Cars. F. A. Delano and G. H. Brommer. Gives a plan of a typical yard and fourteen requirements. 700 w. R R Gaz—March 8, 1901. No. 39742.

Yards and Terminals. Extracts from the report of the Maintenance of Way Assn.'s committee in reference to terms used and their definitions, and matters relating to the location, size, etc., of the yards. 3200 w. R R Gaz—March 15, 1901. No. 39798.

TRAFFIC.

Electricity and Steam.

Some Relations Between Electric and Steam Roads. Editorial discussion of relations brought about by the developments of electric traction; some of the difficulties encountered, and the conditions in New York City are discussed. 3000 w. St Ry Jour—March 2, 1901. No. 39658 D.

Freight Departments.

Two Well-Managed Express and Freight Departments. Operating details of this service as illustrated at Rochester and at Albany, N. Y. 2000 w. St Ry Rev —March 15, 1901. No. 39838 C.

MISCELLANY.

Trans-Siberian.

Historical Account of the Trans-Siberian Railway. G. de Krivochapkine. Abstract translation of article in *Le Genie Civil.* Discusses the economic influence of this railway upon the mineral industries of Siberia. Ill. 2100 w. Eng News —March 28, 1901. No. 40051.

CURRENT RECORD OF NEW BOOKS

The Book Department of THE ENGINEERING MAGAZINE *is prepared to supply any work here mentioned, at the Publisher's price, delivered post paid to any part of the world. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE. *These pages are issued separately from the Magazine, printed on one side of the paper only, for card index purposes in libraries. See introductory to "The Engineering Index."*

Marine Engineering.

Practical Advice for Marine Engineers. By Charles W. Roberts. Price, 2s. 6d., 75 cents. Size, 5 in. by 7 in.; pp. 150. London: Whitaker & Co. New York: The Macmillan Company.

A convenient little handbook describing the duties of the engineer, his relations to the other officers of the ship; the care and management of machinery at sea and in port; hints as to action in emergencies; and much useful information not usually found in the more pretentious treatises.

Flow of Water.

Report on the Measurement of the Volume of Streams and the Flow of Water in the State of New York. By Edward A. Bond, State Engineer. Size, 6 in. by 9 in.; pp. 125. Albany: James B. Lyon, State Printer.

With many tables and data of measurements, and photographs of stations, dams, and weirs, the whole forming an acceptable collection of authoritative data on the flow at various seasons from definite drainage areas.

Boilers.

Steam Boiler Economy. A Treatise on the Theory and Practice of Fuel Economy in the Operation of Steam Boilers. By William Kent, A. M., M. E. Price, $4.00. Size, 6 in. by 9 in; pp. 458. New York: John Wiley & Sons. London: Chapman & Hall.

The extensive experience and high reputation of Mr. Kent gives reason for hearty welcome to this work, which has been awaited with interest. It treats of the chemistry of fuel and combustion, the heating values of American and European coals, furnaces, methods of firing, mechanical stokers, and forced draft. The general construction of steam boilers is discussed and the best method of operating them so as to obtain the highest efficiency. The whole forms a complete treatise on steam boiler economy, and as such it is to be welcomed.

Gas Fuel.

Gas and Fuel Analysis for Engineers. By Augustus H. Gill, S. B., Ph. Price, $1.25. Size, 5 in. by 8 in. New York: John Wiley & Sons. London: Chapman & Hall.

A compendium prepared especially for the use of students at the Massachusetts Institute of Technology, but also of usefulness for those interested in the economical application of fuel. Methods of analysis of chimney gases are given, together with details of the computations and preparation of the necessary reagents. The anaylsis of fuels and the determination of the calorific value are also treated.

Boiler Practice.

Steam Boiler Practice in Relation to Fuels and Their Combustion. By Walter B. Snow, S. B. Price, $3.00. Size, 6 in. by 9 in.; pp. 297. New York: John Wiley & Sons. London: Chapman & Hall.

A study of the principles involved in the production of steam from water, considered apart from the questions involved in boiler construction and design. The treatment includes the efficiency of fuels, efficiency of boilers, and especially the comparative advantages of natural and mechanical draft. The rules of the American Society of Mechanical Engineers for conducting boiler trials are given in an appendix.

Reservoirs.

Reservoirs for Irrigation, Water-Power, and Domestic Water-Supply. By James Dix Schuyler. Price, $5.00. Size, 6 in. by 9 in.; pp. 432. New York: John Wiley & Sons. London: Chapman & Hall.

An excellent treatise, based upon the authors paper prepared for the United States Geological Survey, extensively revised and enlarged. The construction of artificial reservoirs by means of rock-fill dams, hydraulic-fill dams and dams of masonry and of earth are all discussed, and illustrated by examples of actual construction. Much important matter relating to the projected reservoirs based on the work of the United States Geological Survey in the arid regions of the western states is given, and tables of reservoir areas and capacities are appended.

Calculus.

An Elementary Treatise on the Calculus for Engineering Students. By John Graham, B. A., B. E. Price, 7s. 6d. London: E. & F. N. Spon.

A thoroughly practical treatise, intended, as the title indicates, for the engineer. The fundamental principles of the differential and integral calculus are clearly developed, and numerous practical applications are appended.

Fuels.

The Calorific Power of Fuels. By Herman Poole, F. C. S. Price, $3.00. Size, 6 in. by 9 in.; pp. 279. New York: John Wiley & Sons. London: Chapman & Hall.

A new edition of Mr. Poole's well-known treatise, with many corrections and extensions, including additions to the list of fuels, new smoke tests, additional tables, etc.

Roads.

Report of the Commissioner of Public Roads of the State of New Jersey. By Henry R. Budd, State Commissioner. Size, 6 in. by 9 in.; pp. 190. Camden: S. Chew & Sons.

Containing much useful information as to the construction and maintenance of macadam roads, with numerous illustrations of the results of construction work in various parts of the state, together with photographs of roads in other parts of the world. A good map, and numerous tables are included.

Sewage.

Report of the Massachusetts State Board of Health Upon the Discharge of Sewage into Boston Harbor. X. H. Goodnough, Chief Engineer. Size, 6 in. by 9 in.; pp. 100. Boston: Wright & Potter Printing Co.

A complete review of the present sewage disposal of the city of Boston, and an examination of the proposed plan of delivery into the harbor in such a manner and at such a place as will be unobjectionable. An excellent map is appended.

Mechanism.

The Marvels of Modern Mechanism. By Jerome Bruce Crabtre. Size, 6 in. by 9 in.; pp. 750. Springfield, Mass.: The King-Richardson Co.

A popular resume of the development of the various branches of modern industry, showing the relations of material prosperity upon the applications of machinery. With numerous illustrations of ancient and modern works.

Artillery.

L'Artillerie a l'Exposition de 1900. Par Le Colonel X. Price, francs 7.50. Paris: Vve. Ch. Dunod.

A general review of the artillery exhibits at the exposition, with numerous illustrations, and a comparison of the practice of different countries.

Electrical Directory.

The "Electrician Electrical Trades Directory and Handbook for 1901." Price, 12s., 6d. London: George Tucker.

Including the usual valuable handbook of electrical information, also records of electrical undertakings in all parts of the world, and an exhaustive classified directory of the professions and trades connected with electricity in Great Britain, the Colonies, the United States, Asia, Africa, and Central and South America.

Mining.

A Text Book of Coal Mining, for the Use of Colliery Managers and Others. By Herbert W. Hughes. Price, 24s. London: Charles Griffin & Co.

The fourth edition of this well-known handbook, very completely revised and enlarged. The work has been in part rewritten, and is very fully illustrated.

Canal.

Report of the State Engineer and Surveyor on the Proposed Barge Canal from the Hudson River to the Great Lakes. By Edward A. Bond, State Engineer. Albany, N. Y.: James B. Lyon, State Printer.

Giving the surveys and estimates for the three routes from the Hudson River to Lake Erie, with diagram to facilitate a comparison of routes, and much information upon which to base discussion and opinion.

Hydraulics.

Water Power. By Joseph P. Frizell. Pp. 563, 26 tables. New York: John Wiley & Sons. London: Chapman & Hall.

Treating mainly of the collection of water for power purposes, including rainfall, run-off, and the flow of rivers; followed by a discussion of the construction of dams and reservoirs. Methods of calculation, and their application are given to the comparison of various forms of construction for dams.

Dredging.

Concurso Para la Presentacion de Proyectos de Trenes de Dragado. Republica Argentina; Ministerio de Obras Publicas. 7 in. by 10 in.; pp. 240, 42 plates. Buenos Aires: Guillermo Kraft.

The official report of the competition of dredging machinery for the improvement of the harbour of Beunos Aires and the port of Rosario, with complete specifications and plates of the various machines.

THE WORLD IS ITS FIELD.

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BRITAIN AND HER COMPETITORS IN IRON AND STEEL MAKING.

By E. Phillips.

Mr. Phillips' first article appeared in the May number of THE ENGINEERING MAGAZINE. It was devoted to a brief but comprehensive review of the contrasting physical and economic conditions affecting steel production in Britain and the United States. He showed that superior natural resources, and, above all, intense application to the use of mechanical appliances and labour-saving methods, give America an average advantage of £1.5, or $6.25, in the cost of a ton of steel. He now takes up the possibilities open to Britain for reducing this disparity.—THE EDITORS.

PHYSICAL conditions seem greatly to favour the United States in the competitive struggle for dominance in the steel industry, and these advantages have been utilised, as reviewed in detail in my preceding paper, with the utmost ingenuity and mechanical skill in working out economies in mining, transport, and smelting practice. It remains to consider how far and by what means it is practicable to modify the extra charges paid in Britain by the steel maker—how royalties, wayleaves, land payments, and ground rents affect unfavourably the cost of making steel.

There are some costs, in the present state of the laws and customs existing in Britain, with which the British manufacturer will be permanently handicapped, but from which Americans are exempt. Such are the landlords' royalties and wayleaves of from 6d. to 1s. per ton on all minerals, a lesser amount for limestone used for flux and for stone

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and clay for building purposes; payment for land surface on which to build works; and payment for surface land with permission to sink pits and to expend large sums of money to dig down into the bowels of the earth for minerals. The landlord makes it a condition that he shall not be called upon to pay any local rates on the amount of royalties and wayleaves paid to him, or on the ground rents he imposes for houses built in colliery and works districts, or in towns and shipping ports, inhabited by those engaged in the manufacture of iron and steel, its transport on railways, or its disposal at points of shipment. All this means that workmen have to be paid more wages, and employers must add in proportion to their selling prices in order to pay these landlord imposts. Further, the landlord makes provision that his leases of houses, built to form village communities and towns to carry on trade, are granted for a limited number of years only. The lessee agrees that the houses shall be kept in repair and insured against fire, and at the expiration of the lease the landlord "annexes" the house, place of business, or works premises, with its increased commercial value created by the lessee during the period of the lease, without any payment to this lessee. For the future he collects the full increased rental of such premises, instead of the ground rent he previously received. This in plain language is nothing less than a legal permission for landlords to appropriate to their own use other persons' property, with the increased value of the business their industry created. The increased rental may be from ten to twenty times that of the original ground rent, according to what may have been the growth in the business value of the district.

It may be said: "What has this to do with the making of iron and steel?" It has very much to do with it. Take the case of a workman's house costing, say, £150. The certain expiry of the lease at the end of a given number of years, and the absorption by the landlord of the capital invested without compensation at the end of the lease, mean this: that the builder has to obtain the capital he has expended, interest thereon, and cost of repairs, by charging an additional rent to the tenant (to recoup himself during the period of lease) of from 2s. to 2s. 6d. per week, more than if this landlord impost did not exist. Thus extra wages have to be paid by the manufacturer, for the workman must have a living wage left. In this way terminal-lease conditions become an additional percentage tax on the wages of all men engaged in connection with the industry, from the mine to shipping port. Putting it in another form: assuming that the average wages earned by a man are 30s. per week, and that 2s. extra rent has to be paid; this means that 8 per cent. of the workman's wages go to the landlord, and in case the extra rental is 2s. 6d., 10 per cent. of his wages are so absorbed.

Further, large amounts have to be paid the landlords for the land over which railroads have to be made, and land for docks and wharves at shipping ports. This, again, is equivalent to another royalty for being allowed to bring products to market for distribution. The marvel is, that the ancestors of landlords did not also make provision that the same English law which enables them to make the foregoing imposts, should have conveyed a similar legal right to impose a royalty poll-tax on employers and men employed for the privilege of breathing the atmosphere above. There is no reason why they should not have the same proprietary ownership of the atmosphere above the land as of the minerals below, and charge for breathing, utilising, and absorbing it, just the same as they already by law charge for the land and minerals below. But this was no doubt an oversight on the part of the landlords' ancestors.

The Removal or Minimisation of Royalty Imposts:—The nationalisation of land, so as to do away with all royalties, wayleaves, and ground rents, from which other countries are exempt, is too large a question, and is beyond the range of practical legalisation in this generation. What is wanted is prompt and immediate relief. A great deal is said as to sacredness of private ownership of property, and of agreements come to between landlord and tenant in the granting of leases, to pay certain royalties and wayleaves for working minerals and ground rents for houses; but it must be borne in mind that these agreements are very much of a one-sided nature. The lessee of works, minerals, houses, has no option but to accept the landlords' terms, and his other conditions which give him the right to appropriate without payment such property built on his estate at the termination of lease. If the lessee should say, "Such conditions are not right or fair," the landlord replies: "Then if you object to my terms you shall not work the minerals on my estate, or build a house on my land." Putting it in this form, it is at once seen how unfairly one-sided such agreements are.

If Parliament, in its wisdom, finds it necessary in the interest of the welfare of the nation to remove or modify ancient privilege laws to landlords in relief of trade burdens, there is nothing to prevent this being done; there is no such thing as the absolute ownership, either of land or personal property, except so far as it may not be detrimental to the general welfare of the nation. Take the case of the wealth a man may accumulate in his lifetime. What does the State do? The sacredness of absolute ownership is not recognised. One man accumulates during his life personal property amounting to £1,000, another £1,000,000, whilst the third accumulates £10,000,000. The State says to the representatives of the deceased who died worth £1,000: "You shall not be absolute owners of all the money the deceased saved; one per cent., or £10, must be paid back to the Nation." To the others representing the £1,000,000, "you must refund 10 per cent, or £100,000." To the executors of the third, valued at £10,000,000, "you must also refund 10 per cent., amounting to £1,000,000, to the State."

It is to be noted that up to the time Sir William Harcourt brought in his celebrated Deceased Legacy Duty bill in Parliament, the landlords, with their well-proven shrewdness, had taken good care that they should be exempt from paying legacy duty on land values of their estates, paying only on the value of their personal property; but Parliament in its wisdom changed this law. The result is that the representatives of deceased landlords' estates in land have now to repay to the Nation annually large sums, which they previously pocketed by the protective exempting law they had created. Parliament having done this, there is no reason why they should not also pass a "Relief Royalty and Ground-Rent" bill cancelling the present iniquitous provision in leases permitted by the present law. This would minimise the burden of these imposts on iron and steel industries.*

What I propose would be a short bill, with only a few clauses, which might be passed at the next Parliament without disturbing existing royalty mineral leases, leases of works, ground rents, or leases for houses and buildings. The two clauses should reduce royalties and ground rents to one-third, or one-half, of what they now are. Here is my suggestion.

1.—All royalties and wayleaves on minerals, rents of land for works, docks, railways, etc., together with ground rents for houses and business premises, etc., shall be subject to local taxation, the same as other rateable property.

2.—All these royalties, rents, etc., above named, shall also be subject to an additional imperial tax of 25 per cent. of such payments in relief of national burdens, which indirectly would relieve manufacturers in all trades.

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* At the time of the passing of the Reform bill of 1832, Pitt brought in two bills, one to tax personal property, the other landed property. At that time every member of Parliament was a landlord. These patriotic gentry passed the bill taxing the business man's personal property, but threw out the bill to tax their own landed property. This exemption continued till the passing of Sir William Harcourt's bill.

It may be said: If this were done, what is to prevent the landlord in all new grants for minerals or of ground rents for houses and places of business, from charging increased royalties and ground rents to recoup himself of what the new law made him pay?

This I should check-mate by a few simple clauses added in the bill, viz.:—

3.—In the case of royalties of minerals, let after the passing of the bill, no larger royalty amount shall be charged nor for land required than the customary one paid previously in the respective districts, on a basis of an average of the amount at which it was let during the previous ten years for similar minerals and land.

4.—In the case of ground rents, there shall be no increase of that charged for buildings recently erected, the average of that of the previous ten years to be the standard.

These two clauses would prevent any additional imposts at any future time or the continuance of the annual increased increment to landlords, which would remain at what it was at the time when this act became law.

Then as to the appropriation of property in houses, at the termination of the lease, I would have the following clause:

5.—At the expiration of all leases it should be compulsory upon landlords to grant a new copyhold perpetual lease, and in lieu of the landlord's right under the lease to "annex" such houses without payment, he should be paid an increased ground rent, on the following basis: If, say, the original ground rent in the lease was at that time £3 annually for a house letting at £21, and if by the end of the lease the ground rents for similar allotments had gone up to £10 and the rent of the house had also gone up to £100, then instead of the landlord being allowed to appropriate the property and receive the £100 a year, for premises for which he was before receiving £3 annually, he should receive the increment growth of ground-rent values during the period of the lease, which in this case would be £10, instead of the £3 under the lease; the ownership of the property clause at the expiration of the lease being cancelled, and the increased present ground-rent value only payable for all future time.

This change in the law would be only similar to that which was made in recent years in another form, in the case of a landlord's estate in land valued at say £1,000,000, for which deceased's successors were exempt from paying legacy duty, but have now to refund back to the Nation one tenth of it, amounting to £100,000. The relief here specified could very considerably ease royalty charges by lessening the burden of local taxation, and in course of time would lower workmen's wages, as well as national taxation, and change the spoliation of the capital value of buildings by the landlords at the termination of the lease to the receipt of an increased ground rent, as indicated.

British Railway Rates. No material relief is to be expected by a reduction in tolls, works in the north of England being on the seaboard, and in Wales but 20 to 25 miles inland. Still, even in this the monopoly enjoyed by railway companies enables them to charge excessive rates, so as to pay large dividends.

Continental railways are generally owned and worked by the State, and the rates are much lower than in Britain. Take the case of the year 1895 as a typical one, when coal was at a normal rate, which that year averaged 6s. 5d. per ton. If the number of tons carried be divided into the income earned for carrying the coal, it works out 1s. 7½d. per ton. German and Belgian railways, carrying the same quantity the same distances, would make rates of less than 6d. per ton, or 1s. per ton difference. Besides this, there is the anomaly of British railways carrying foreign goods consigned to the country at from one-half to two-thirds less than home goods, thus giving a premium to the foreign shipper. Astonishing as it may be to the reader, yet it is an absolute fact, such is America's advance in the movement of traffic on railroads, that it does not cost the Carnegie Co. more to take their ore from Lake Erie to Pittsburg, a distance of more than 150 miles, than it does in Wales to take the ore the short distance of a little over 20 miles. I question if it costs as much, and for illustration give the facts:—The powerful Carnegie engines of 127-tons' weight take from the Lake port to Pittsburg thirty wagons carrying 50 tons each of ore, 1,500 tons at one time; the tare of these 50-ton trucks is only 15 tons each, the total dead weight being 2,100 tons. If this 1,500 tons was required to be sent, say from Newport to the Blaenavon or Ebbw Vale Works, some fine morning (and about the same would apply from Cardiff to the Dowlais and Cyfarthfa works) how many 10-ton trucks would be required to take the 1,500 tons and how many engines would have to be brought out of the sheds to start, one after the other, with this 1,500 tons of ore? It would require one hundred and fifty trucks, the tare of each being 5 tons. The engines employed could not take right through to works more than 150 tons each of ore in fifteen 10-ton trucks, so that it would require *ten engines* and thirty men, with a dead weight of ore, trucks, and engines of about 2,500 tons, to do the conveyance of the 1,500 tons, which is done in America with *one* engine and three men only. Consider what the extra wages must be for twenty-seven more men engaged to do the same work, and the extra coal and stores used by ten engines instead of those required for one engine. The extra time taken to go the longer distance would have to be taken into account. This is the kind of thing that goes on (more or less) to ensure dispatch and quantity in all departments from the mine to the mill in America.

The relief from these costs can be obtained only by the removal of the Welsh works to the seaboard, where they may have ample space (which is not available in the narrow valleys where works are located) and elbow room to marshal supplies and arrange production so that the ore may be taken direct from steamer to furnace close at hand. This has already been done by the Dowlais Company for a portion of their works, in close proximity to the Cardiff Docks, where further extensive plant and latest improvements is in course of being introduced. Similar developments have also been carried out at the Moss Bay, and other works in the north of England.

What British Manufacturers Must Do to Reduce Costs. New capital must be forthcoming to erect new and re-construct old works, with furnaces and plant of latest type, utilising every electrical, hydraulic, and mechanical labour-saving appliances, so as to ensure great dispatch and a large production, which of necessity will mean fewer hands employed for an equal tonnage.

The Question of Difficulty with Men and their Unions. Unfortunately for the men, for the time being, the new methods will dispense with the employment of a considerable number, their previous work being done mechanically. The employers will no doubt have great difficulties with English workmen and their unions, in the introduction of methods curtailing the number of men to do the work; but in this inquiry, we have to set aside the question of how many or how few men are to be employed. The fundamental question is: What are the conditions under which America makes steel at such a low price, that she can undersell the English manufacturers in their own home and in foreign markets previously supplied exclusively by them?

If men and their unions will not co-operate by working with labour-saving methods, so as to ensure as far as possible reduced costs, how is it possible for employers to compete with America? Orders will go elsewhere and works be closed, and the need of their employment would cease. Whether the men realise it or not, England is face-to-face with a commercial war of competition with America and Germany that will tax her best energies to retain at all even a goodly share of her previous markets for steel (as well as for all other manufactures), and the next decade will see a far greater retrogression and falling off of trade than in the last, unless every means that science and mechanical skill can devise be allowed to have a free scope, and the co-operation of all men be given, notwithstanding that the number employed may temporarily be fewer. It would be nothing less than commercial suicide on the part of the men and employers not to profit by the study and the practical application of what is done by other countries. The policy of the men and their unions in the past has been to resist the introduction of labour-saving machinery that would increase production at a lower cost. But experience in all such mechanical revolutions has been that, whilst for the time being numbers of men may be displaced, in the long run more men have been employed than previously, for the simple reason that cheap production creates a greater demand for an increased quantity. The policy of the men and their unions has been to restrict production, to do less work, but to demand more pay and work fewer hours. The American policy is the opposite to this. The men work harder there than in England, work longer hours, and go in for the greatest output that their powerful machinery makes it possible to turn out. And in doing so they earn much higher wages than in England. And this policy on the part of the employer in equipping his mines, of the engineer in the design and introduction of machinery for rapid production and transportation, of the men in complete co-operation combined with the highest technical and scientific knowledge, accounts for the advantages the United States possess for producing cheaply and underselling others who continue working on antiquated lines.

Suggestions for the Reduction of Cost of Ore and of Freights. At present an average of 5s. per ton more is paid to Spanish mine owners than it costs the American at Lake Superior, with another 2s. 6d. more for freight for transportation to England. This, for the two tons of ore necessary to make a ton of steel, runs the extra cost for ore to 15s. per ton on the finished product. This, of course, does not apply to manufacturers in the north of England and Scotland, who work their own ore mines and have no freight to pay, and to that extent they are able to make steel cheaper than those using imported ore from Bilbao. A reduction in the cost of ore and freight is possible under the following conditions:

First:—Direct reduction in price of ore, by the acquisition of Spanish mines.

Second:—Raising the present maximum of 0.025 per cent. of phosphorus in imported ore to 0.050 per cent., as in America.

Third:—Lowering freight by improved shipping facilities at Bilbao, and at ports of delivery.

1:—Acquisition of the Spanish Mines. To accomplish this British manufacturers should combine to form a powerful mine trust, with ample capital, to secure Spanish mines by purchase or such other arrangement as may be made with the numerous mine owners, (making a combine of the group, as was done in the case of the gold mines of the Transvaal), and further to secure the rights of working other large well-known areas of ore inland, and to make railways from these to tidewater. This has already been done to some extent by individual firms, such as the Dowlais Co., Cammell & Co., Consett & Co.; but for the larger scheme it would no doubt be possible to arrange with these firms to join in the formation of a combined mine trust. The apportionment price of the different qualities is one of detail which we need not here consider. By such a combination, the price of ore would not be subject to present fluctuations, such as during the recent boom, from 7s. to 14s. at Bilbao. The present large profits made by Bilbao mine owners would to a great extent be saved. By such a combination the cost for ore on board at Bilbao would be very much less than at present.

(2)—Standards of Phosphorus Contents. American manufacturers accept ore containing 0.045 per cent. to 0.05 per cent. of phosphorus, their maximum in good finished steel being 0.10 per cent. of phosphorus and 0.10 per cent. of carbon. Steel rails, tin-plate bars, girders, ship plates and angles, merchant bars, and engineering work of all kinds, with this maximum of 0.10 per cent. of phosphorus, are accepted by buyers in Britain and all the world over. On the other hand, British manufacturers are at present tied down by the stipulation that delivery of steel will not be accepted except on the basis of 0.06 per cent. to 0.07 per cent. maximum of phosphorus. The effect of this in the past has been that they could not accept imported ore, except on the basis of 0.025 per cent. of phosphorus, under heavy penalties.

It appears that an eminent chemist some years ago gave it as his opinion that the maximum of phosphorus and sulphur in good steel should not exceed 0.06 per cent. of each, and 0.10 per cent. of carbon, and to this standard British manufacturers have since had to conform

But I am informed by a local consulting chemist of well-known repute, who also has a practical knowledge of the working and management of blast furnaces, that many years ago he had determined by chemical investigation, and had so advised manufacturers, (as also later on had other chemists), that good steel may contain 0.10 per cent. of phosphorus, 0.05 per cent. of sulphur, and 0.10 per cent. of carbon; but not more than 0.05 per cent. of sulphur and 0.10 per cent. of carbon; as it is desirable, in the case the phosphorus runs up to 0.10 per cent. in finished steel, to have as much less than 0.10 per cent. of carbon and 0.05 per cent. of sulphur as possible (more especially less of sulphur). This has now proved to be correct by the fact that American steel of the chemical contents of 0.10 per cent. of phosphorus is used for all purposes in the States, and is accepted both in Britain and in other countries. Yet British makers are restricted in their productions to 0.06 per cent. of phosphorus.

We are informed that the American soft steel will not bear deep stamping, such as British steel will readily do.

The first thing British manufacturers should do, and at once, by an united combination, is to insist that buyers should accept British-made steel of the same maximum—0.10 per cent. of phosphorus—as they do American.

The result of this change (raising the standard of phosphorus in steel to 0.10 per cent.) would be that the British manufacturers would be able to use ore of 0.045 per cent. to 0.05 per cent. instead of being confined, as now, to 0.025 per cent. There are many millions of tons of ore at Bilbao in the numerous mines now rejected, ranging from 0.03 per cent. to 0.05 per cent., which may be obtained at a very low price. This would very materially reduce the price now paid, as miners are now restricted to select ore of 0.025 per cent. contents.

Something need be said also, respecting the British manufacturers' stipulation that ore shall not contain more than 0.025 per cent. of sulphur. I am informed by the chemist above referred to that there is also no justification for the stipulation of a penalty if ore contains more than 0.025 per cent. of sulphur, providing it does not exceed 0.05 per cent., for the simple reason that, unlike phosphorus, (none of which is eliminated in the blast furnace), a great portion of sulphur is eliminated if the furnace is in good working order, as it always should be; no injury, therefore, will result to the steel if the sulphur in the ore does not exceed 0.05 per cent. The new maximum standard for both phosphorus and sulphur in ore may, therefore, be raised from 0.025 per cent. each to 0.05 per cent. each.

Improved Facilities at Bilbao and at Ports of Discharge. To reduce present rate of freights, the proposed combination should have increased tips and improved methods for the more rapid loading of steamers. These should be provided also at ports of delivery, although it may be impossible to do at Bilbao what is done at Lake Superior, where a 6,000-ton boat is loaded in less than a day—in fact, in a few hours. Still, it is quite possible that a 2,000-ton steamer could be loaded in one half the time now taken. At present a condition of the charter is to load and discharge at the rate of only 300 to 400 tons a day; if this were raised to 1,000 tons, loading and discharging by improved shipping and discharging arrangements, ship owners could accept at least 6d. per ton, if not 9d. per ton, less freight, being well reimbursed in the ship's time, wages, etc., saved. When it is considered that this would mean 1s. to 1s. 6d. less for freight on every ton of steel, it will at once be seen that an expenditure for such facilities is of the first importance.

It may be fairly assumed that a mine trust, working their own mines and making improved shipping facilities, after allowing a moderate interest on capital invested, would obtain their ore at from 5s. to 7s. 6d. less than it now costs them, which would mean 10s. to 15s. per ton of steel.

Saving in the Price of Coke. Antiquated modes of making coke should be done away with, and the bye-product system should be adopted, as is now the case in the best up to date foreign works. The utilisation of gas and sale of the bye-products very largely, if not altogether, pays for the coke.

The proverbial conservatism of Englishmen in the past has had much to do with their delay in accepting the new conditions in good time, retarding, rather than adopting, new methods, preferring to stick to the old ruts. It is to be hoped that the necessities of the competition, which has threatened to overwhelm them, will convert them to the adoption of a more progressive policy for the future: otherwise their former pre-eminence as iron and steel makers will very shortly come to an end.

American Inroads on the British Tin-Plate Trade. During the past decade, quite a revolution has taken place in shifting the manufacture of tin plates from England to America.

Ten years ago, America took 75 per cent. of the British make, amounting to something like 6,500,000 boxes annually; this has now fallen off to 1,250,000 boxes, and the fraction has been retained only by the arrangement to allow back on re-exportation a rebate of 99 per cent. for plates used in the petroleum, fish, and fruit "canning" business.

The growth of this industry under the McKinley tariff is seen when we note that in the year ending June 30, 1892, the American make was 13,646,719 pounds (124,000 boxes) but for the year ending June 30, 1899, their make was 791,371,438 pounds, or 7,327,500 boxes. Now the Americans contemplate absorbing the 1,250,000 boxes at present supplied by Britain, for the canning business. Indeed, they have already begun doing so, for it is clear that if the Americans can afford to send bars to England to make tin plates at a cost of more than £1 per ton, to be sent back for their canning trade, they could make these plates in their own works, as the 25s. to 27s. 6d. per ton they now pay to send bars to Wales would cover the extra wages in mills and tinning departments. As a matter of fact, the tariff is not now necessary to keep out this trade, nor to protect the general American home trade. The tariff is now really retained to enable iron masters to charge a high price for bars to the tin-plate makers, and by so doing swell their large profits, which of course their own home consumers have to pay.

American and British Tin-Mill Output. An illustration of the same differences I have traced throughout the iron trade, as they affect the output in mills, will be interesting. The British mill men and their unions restrict the output to thirty-six boxes per 8 hours, or one hundred and eight boxes per day, whilst the American mill men, with their powerful machinery and mill plant, produce sixty boxes and even seventy-five boxes in each 8 hours, or over two hundred boxes per turn. Think what this means. In Britain the maximum make is six hundred boxes per week, whilst in America it is twelve hundred boxes per week, *one* mill plant and *one* set of men doing the work of *two* English mills and *two* sets of men, with the additional extra costs for coal, and doubling of all fixed expenses.

A further movement contemplated on the part of the American tin-plate trust is to obtain their tin direct from the Straits Settlements, by an arrangement with the producers, the quantity now used in America for coating tin being 10,000 tons annually. At present both British and Americans have to purchase their requirements from the London tin merchants, who import and control the price to be paid for tin, so much so, that we have seen the price fluctuate from £50 to £160 per ton, a different ranging from 6d. to 1s. 6d. per pound, and during the recent boom it has ranged from £75 to £145. The tin-plate makers, being at the mercy of the London tin operators, pay the price they demand. It is evident that the cost of obtaining the tin is much about the same at all times. It would be safe to assume that the proposed tin-plate corporation would secure their 10,000 tons annually at £20 per ton, less on an average, than is paid as it is now obtained. This would be over 2d. per pound, and as nearly 3 pounds is used for coating a box, the saving in tin would be 6d. per box. This, combined with their cheap production of tin bars, notwithstanding that they have to pay considerably more wages per box than in Wales, would enable the American tin-plate trust to come into competition with England, during the current decade, for a share of the outside world's requirements. Of course, it is quite possible for English tin-plate manufacturers to form a combine for the same purpose, and this they should do in self defence, but will they do so? I fear not; past experience of co-operation in other directions has been anything but satisfactory, chiefly from the outcropping of selfish motives and the impossibility of harmonising financial considerations.

New Works at Sydney, Cape Breton. It has long been known that immense tracts of rich ore and coal existed in Canada, in convenient proximity to shipping ports. Extensive areas have been secured by The Dominion Steel and Iron Company, with a capital of $20,000,000, who already have four up-to-date blast furnaces under construction or at work, of the latest type and large dimensions. Also a number of open-hearth furnaces, a 35-inch blooming mill, pit furnaces, four hundred Hoffman coke ovens, a coal-washing plant, and large machine shop and foundry, all combined capable of developing the largest output. At a meeting of the directors recently held at Montreal, it was decided to proceed at once with the erection at Sydney of plant for the manufacture of steel rails, bars, and ship plates.

The company have also decided to issue new capital for the purpose of establishing a large ship-building business at Hamilton, some 150 miles from Sydney. Sydney is destined to be one of the greatest shipping ports of Canada, the largest steamships built being able to get alongside the stages of the works at all states of the tide.

The company has also provided against any difficulty connected with the closing of the port by ice for a short period in winter, by connection of their works by railway with the harbour of Louisburg, which, though distant from Sydney but 22 miles, is open all the year round. Six steamers are being built to carry coal between Louisburg and Boston, U. S. A.

The ore at furnaces is said to cost only 4s. per ton, coke 6s., and limestone 2s. 3d., and works out as follows:—

1.80% Ore to the ton cost	$1.80	
1.25% Coke to the ton cost	1.80	
75% Limestone cost	.40	
Labour, repairs, etc	1.50	
	$5.50	equal to £1.3.0
Conversion into steel	5.00	equal to 1.1.0
	$10.50	equal to £2.4.0

The comparison with costs in the United States and England will therefore be as follows:—

	Cost of Pig.	Cost of Finished Steel.
In Britain	£2.10.0	£3.15.0 (in normal times)
In America	£1.10.0	£2.10.0
In Canada	£1. 3.0	£2. 4.0

The advantage the Canadian new works possess over those of the United States is that their coal and ore are in close proximity to furnaces and can be moved at one handling entirely by cheap water transport, with no transportation of the products to port for exportation. With this they combine a very cheap cost for mining.*

The natural conclusion from what has been advanced in this paper is that with further extensive developments likely to take place during the next ten years, we shall find Canadian works competitors with America, Germany, and Britain for the steel requirements of the world.

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* THE ENGINEERING MAGAZINE has in preparation a complete illustrated account of this significant enterprise, with data of the ore supplies and their quality, character of the fuel, and other points of importance. The paper will appear in our July issue.

TURBINE BUILDING AND TURBO-ELECTRIC STATIONS IN SWITZERLAND.

By Franz Prášil, Professor at the Federal Polytechnic Institute in Zürich.

The first section of Professor Prášil's review, published in our May issue, was concerned with the rise of turbine building in Switzerland, the equipment and capacity of the great turbine-building works, and the hydro-electric installations erected since 1889. These plants at Berne, at Zürich, on the Aar, at Rathausen, and in Zufikon-Bremgarten, by consecutive advances in successful practice, led up to the important stations described in this concluding paper.—The Editors.

BETWEEN 1888 and 1889, as shown in my preceding article, may be found a starting point of modern progress in hydro-electric engineering in Switzerland—the first appearance of stations containing a number of similar units. The earlier of these—those at Geneva, Zürich, Schaffhausen, Berne, the plants on the Aar, and the stations at Rathausen and Zufikon-Bremgarten—have been already referred to. I reserved for this paper the description of the stations at Chèvres and Rheinfelden. The energy, perseverance and thoroughness with which the whole question had been studied are proved alone by the fact that, without the experience to be gained by a gradual transition from smaller enterprises, people had the courage to begin the work for the utilisation of such an enormous amount of energy as 22,000 horse power, and this in the face of the difficulties due to a comparatively small and, at the same time, widely varying head of water. For there can be no doubt that it would have been very difficult to raise the large amount of capital required for this undertaking, if the plans had not clearly shown the probability of their realisation.

The Chèvres plant is about 6 kilometres (3.7 miles) downstream from Geneva, and is designed to use the water-power available at this point to generate electrical energy for Geneva and its vicinity. The water supply is furnished by the Rhone, which has already been regulated by the Coulouvrennière installation, and by the Arve, with its widely varying volume. The water-power is made available by means of a sluice-weir, Figure 9, and a head-race 136.5 metres (448 feet) long leading to the turbines. The weir has seven sluice-gates, each 10 metres (32.8 feet) wide and 8.5 metres (27.9 feet) high, which are built between piers, each 17 metres (55.8) feet long and 3 metres (9.8 feet) thick. Each gate weighs 50 tons and has a water pressure on it of 360 tons, and the whole weir forms a structure of great strength. In winter, when the volume of water is 120 cubic metres (4,240 cubic feet) per second, there is a head of 8.5 metres (27.9 feet), whereas in summer with 900 cubic metres (31,800 cubic feet) per second, the head is only 4½ metres (14.8 feet). The tail-race is formed by a wall starting at the dam, and built in the bed of the Rhone, 130 metres (430 feet) long, 2 metres (6.5 feet) thick and 4 metres (13 feet) high.

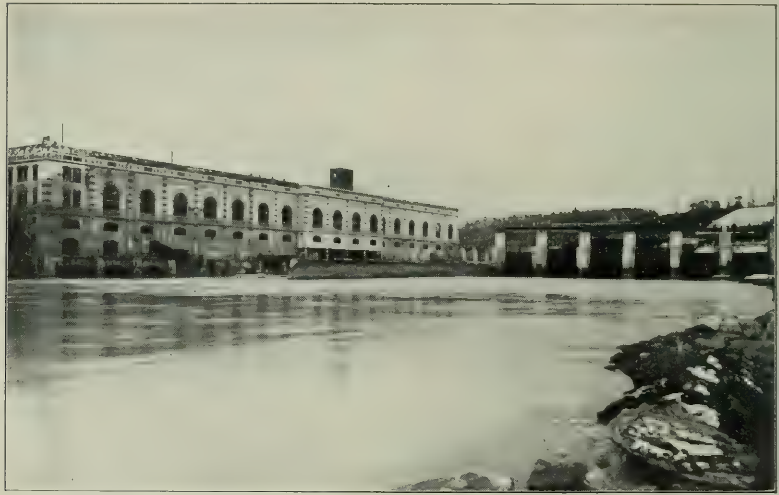
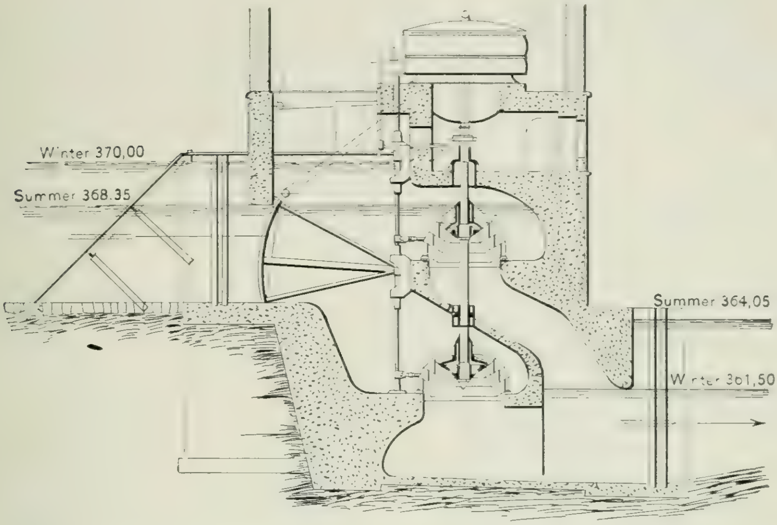


FIG 9. THE WEIR AND GENERAL VIEW OF THE CHÈVRES PLANT.

In order to operate the sluice-gates, a steel bridge was erected on the piers, and the lifting mechanism was attached to the trusses. This part of the installation was designed by the English engineer, Stoney; the steel work was carried out by the firm of Schmidt, and the lifts were built by Piccard & Pictet, both of Geneva.

The turbine house, which lies nearly parallel with the river, has a length of 136.5 metres (448 feet) and a width of 12.5 metres (41 feet) and is designed to accommodate 15 principal turbines with their directly-coupled generators. The building also contains two 150-horse-power turbines with directly-coupled continuous-current exciting machines, besides all the apparatus for distributing the current, a complete pumping and filter plant for oil, a workshop, and several offices.



The building foundations, the bridge piers, the tail-race wall and the works for protecting the river bank are all built of concrete, resting on sandstone.

Of the fifteen turbines, supplied by Escher Wyss, five are of an

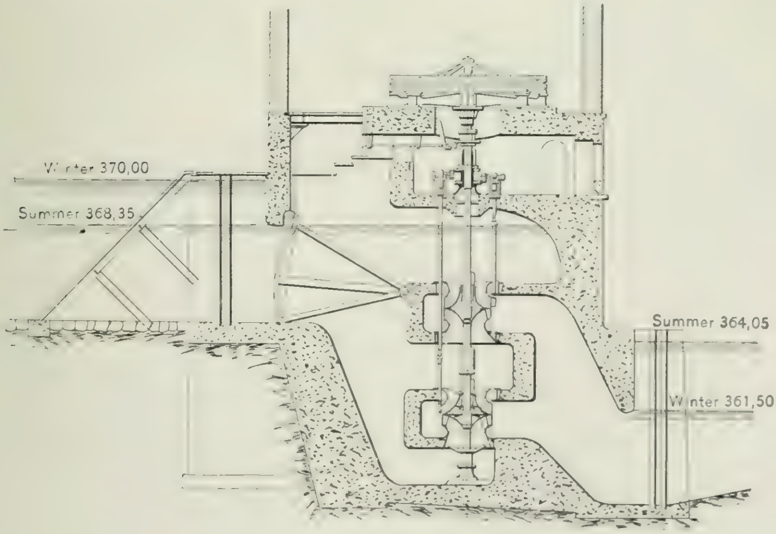


FIG. 10 HYDRO-ELECTRIC STATION AT CHÈVRES, NEAR GENEVA.
The upper view shows the turbine arrangement of the old installation; the lower one shows the new turbine plant. Built by Escher Wyss & Co.

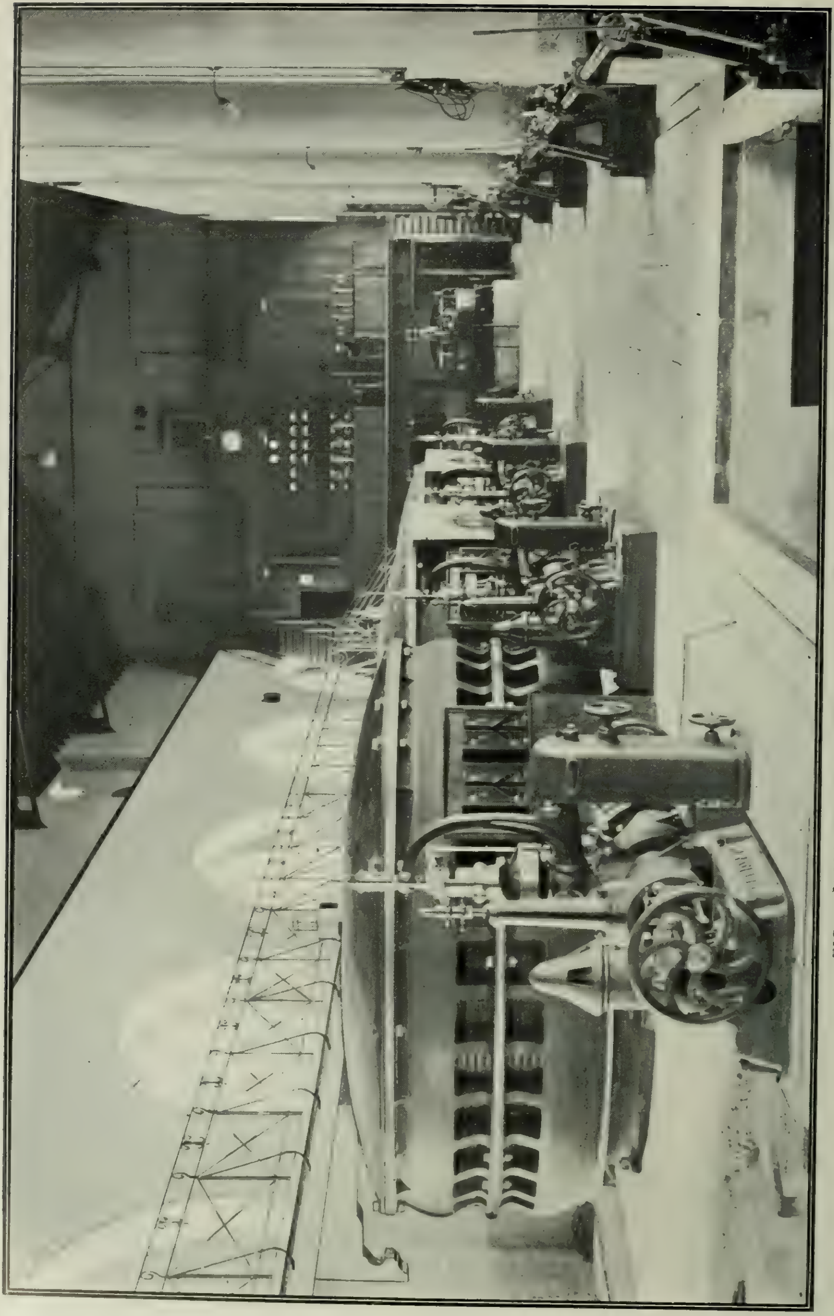


FIG. 11. OLD GROUP OF TURBINES AT CHÈVRES, NEAR GENEVA.

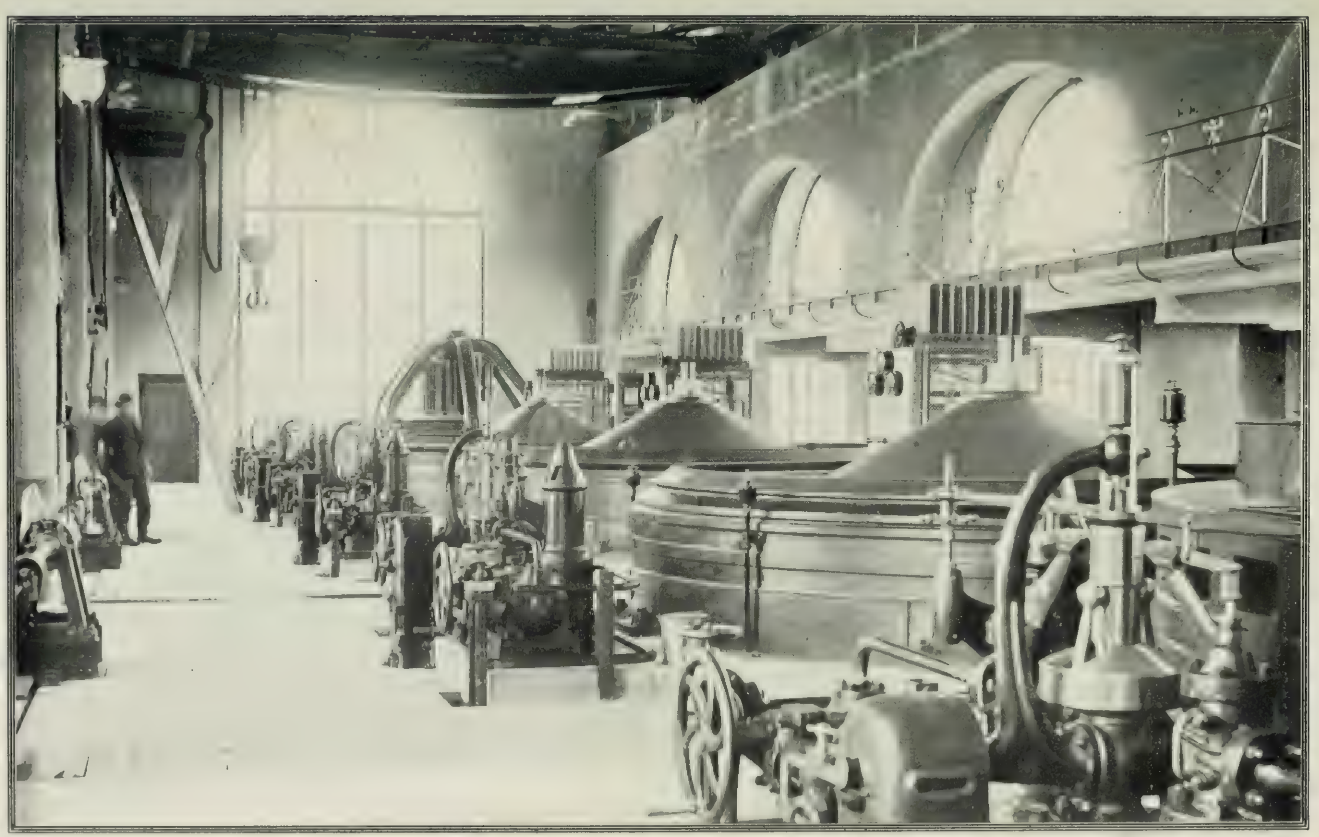


FIG. 12. NEW GROUP OF TURBINES AT CHÈVRES, NEAR GENEVA.

older construction and the remaining ten of a modern form, as may be seen by Figures 10, 11, and 12.

The older turbines are double ones, as two wheels are keyed to one and the same shaft, each with its own guide-blades. The water chamber of each of these double turbines is divided into two parts by an S-shaped concrete-steel diaphragm, so that there is an upper turbine and a lower one, which, except for their connection through the shaft, are almost independent of each other. The lower one works with a large pressure-head and an extremely small suction-head; the reverse is the case with the upper one.

In winter, when there is a high head and a very low level of water in the tail-race, only the lower turbine is in operation, and, when wide open, it develops 1,200 horse power. In summer, with a small head and high water in the tail-race, both turbines are in operation, and, when fully opened, they deliver 400 horse power apiece. While doing this, they run at a constant speed of 80 revolutions per minute, and in order to preserve this steady speed they are constructed with the diameter of the guide wheels decreasing toward the top so that the whole turbine has a conical shape. The lower turbine also has a greater average diameter than the upper one, and both are divided into three rings, so that the large amount of water flowing through them will be exactly guided. The turbines are regulated by an automatic governor. This is, essentially, one with a hydraulic servomotor (or working motor), in which, however, oil is the working fluid. The adjustment is such that, while the regulating gates of both upper and lower turbines are controlled by a single centrifugal governor, yet when the upper wheel is closed, only the gates of the lower one are moved, and when both wheels are open, only the upper gates are operated. The transition from one method of operation to the other is effected automatically.

The ten newer turbines are multiple centrifugal wheels, and they were constructed with a view to increasing the speed as much as possible, 120 revolutions per minute being attained, and also to secure the best distribution of the water available at any time by corresponding variations of the cross section of the openings.

Moreover, these ten turbines are designed so that half of them will be used with the high heads of winter, the other half with the low summer heads. They also are regulated by oil-pressure governors.

The power derived from the turbines is transferred into electrical energy in the directly-coupled generators, and is used partly in the form of two-phase current for light and power and partly as continuous current for operating an electro-chemical works. It may be mentioned that, according to the *Schweizerische Bauzeitung* for 1892, volume XX., page 62, the total cost of the finished plant was estimated at 6,000,000 francs, 3,000,000 francs of which were for the hydraulic part.

In the near future the city of Geneva will issue a complete official report on this undertaking, which is of very great technical and economic importance and highly interesting in every respect.

The station at Rheinfelden, shown in Figures 13 and 14, whose turbines were also built by Escher Wyss & Co., and which has already been treated in literature from many points of view, ranks with the one just described. With respect to the turbines, the plant is characterised by the division of each wheel into eight rings, which, in their form and in the way the water is led to them, correspond to the Francis design.

In this installation we also find two forms of construction, the nine older wheels being designed for 55 revolutions per minute and the eleven newer ones for 68 revolutions. The regulation is effected through sluice rings worked by oil pumps of a similar construction to those at Chèvres. Each turbine develops 800 horse power with heads varying from 4.5 to 3.8 metres (14.8 to 12.5 feet).

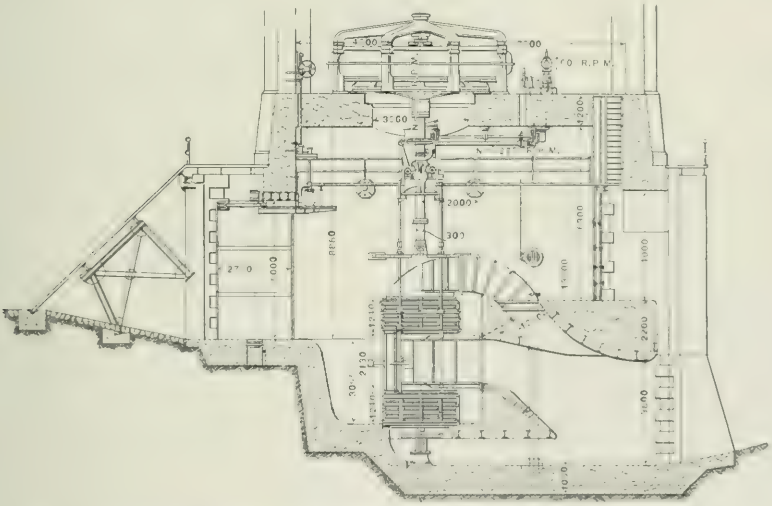


FIG. 13 SECTIONAL VIEW OF TURBINE ARRANGEMENT AT THE RHEINFELDEN POWER STATION

These turbines indicate unmistakably the intense striving after a comprehensive adaptation to the requirements and needs of a com-

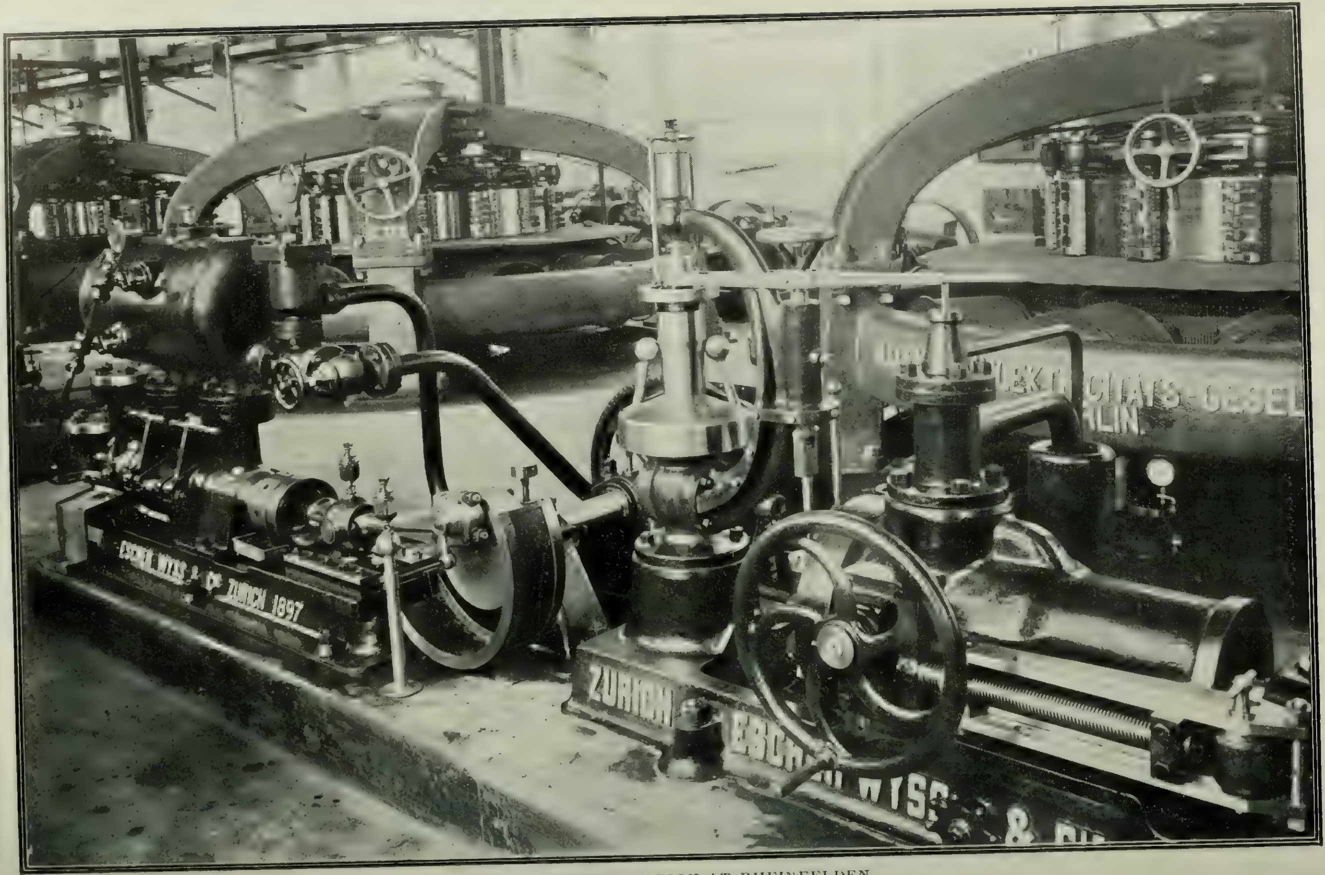


FIG. 14. POWER STATION AT RHEINFELDEN.

bined hydro-electric installation, and mark a decided step forward, which is a proof of the thorough technical knowledge, not only of the men to whose initiative the origin of these plants is due, but also of the engineers who were intrusted with the construction and erection.

It can be readily understood that with the many high falls of water which are available in the steep upper valleys of the Alps, the manufacture of the so-called high-pressure turbines would also be well developed. The early designs of these wheels naturally resembled some of the well-tried forms: The partial-Girard turbine on a horizontal axis, the tangential wheel, the Pelton wheel, the spoon-shaped wheel, and all their different variations were used; and the builders have been principally employed in combining the regulating apparatus of the turbine itself with the automatic governor, in the construction of bearings with automatic lubrication and with shaping the form of the wheel in general.

In 1881, engineer Bosshard, of Zürich, first applied the hydraulic servomotor to a tangential wheel, the valve of the former being moved by an automatic governor, and brought this arrangement before the technical world at the Swiss Exposition, at Zürich, in 1883. In 1886 and 1887, Bosshard had already employed buckets with double-troughs. In 1885, Escher Wyss & Co. built the first high-pressure turbines with spoon-shaped buckets, and soon afterwards this same firm also employed the hydraulic servomotor, which was from the first supplied with all the details which experience and theory have shown to be necessary for the proper operation of a regulator. The Ateliers de Constructions Mécaniques in Vevey have built Pelton wheels since 1894. The remaining turbine manufacturers of Switzerland devoted themselves more particularly to the partial-Girard turbine.

The ever-increasing requirements for exact regulation now led to forms of construction, which, when shown at the Swiss Exposition in Geneva, in 1896, gave an excellent idea of the state of the Swiss turbine manufacture in that year. Among the typical instances of progress should be mentioned:

The compact arrangement of the high-pressure turbines and their regulators as a unit, the careful adjustment and lubrication of the bearings of the rapidly-moving shafts, the suitable application of water-deflectors behind the wheels, the comprehensive employment of spring governors, the careful construction of regulating valves of hydraulic servomotors, the application of mechanical servomotors to high-pressure turbines, and finally the automatic pressure regulator, which was shown in various forms at the above named exposition by Escher Wyss and Bell. This last apparatus arose from the effort to prevent the water hammer which would take place in long pipes on the sudden closure of the regulating gates, and it consists essentially in an automatically actuated relief valve, which is placed in the pipe before the turbine.

Parallel with this briefly-sketched development of the high-pressure turbines proper, which receive their water from a guide apparatus with one or, at the most, two divisions, runs the evolution of the high-pressure turbine with guide-blades half-way or all-the-way around the circumference, which was constructed in compliance with the demand for single wheels with large capacities at heads of 50 to 100 metres (165 to 330 feet).

In the front rank of this class is the machinery in the hydro-electric station at Wädensweil, on the Sihl, built in 1893-1895, where Escher Wyss & Co. have installed five Girard turbines, each developing 400 horse power with a head of 65 metres (213 feet), net, and at a speed of 360 revolutions per minute.

The turbines are constructed with vertical axes for direct coupling to the generators, and work at their full capacity with water flowing in along half their circumference; the regulating sluice-gates are operated by an automatic governor, through a hydraulic servomotor.

Owing to the necessity for making the most economical use of the head of water, these turbines were provided with the Meunier apparatus, which was here employed for the first time in Switzerland. This apparatus regulates automatically the supply of air in the suction pipe below the wheel, so that the Girard turbine can run in air in the discharge pipe, independently of the varying level of the water in the tail-race.

The water-works connected with the installation are of great interest. They consist of a weir built in the Sihl, with sluice gate, gravel-way and spill-way; a conduit 2.2 kilometres (1.4 miles) long; a reservoir with a capacity of 250,000 cubic metres (8,800,000 cubic feet), which is formed by the side of a hill and by a tamped earth dam 107 metres (350 feet) long, 15 metres (50 feet) high and 63.5 metres (208 feet) thick at the base, and a steel-plate pipe 1.5 metres (5 feet) in diameter and 705 metres (2,313 feet) long, which, at a suitable place, has an air pipe to prevent hydraulic shocks.

Other plants of this class are: The hydro-electric station of La Goule, also constructed by Escher Wyss; the plant for the Jungfrau railway at Lauterbrunnen, built by Rieter & Co.; the new installation

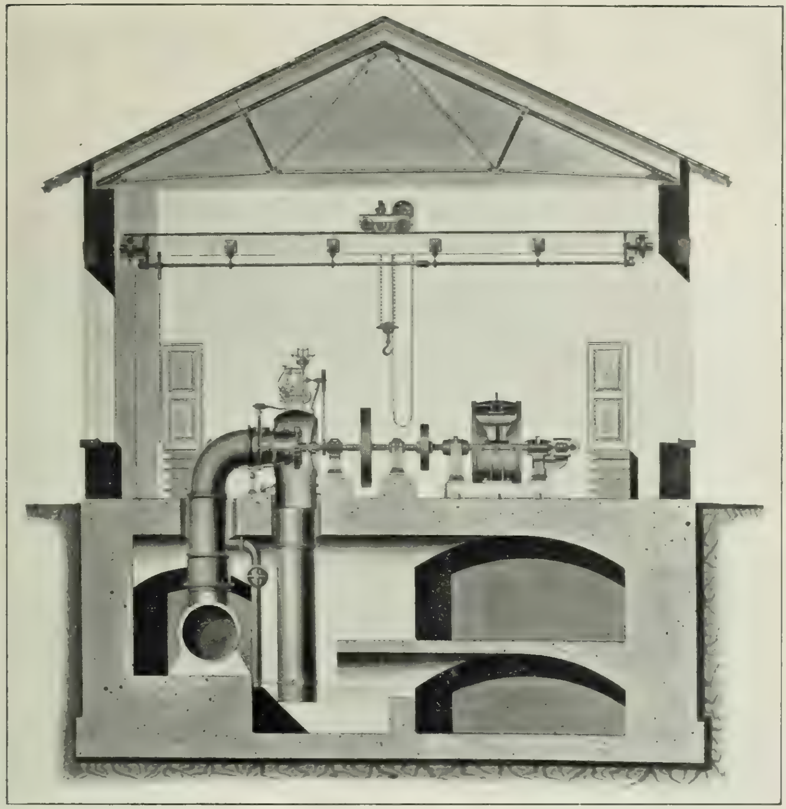


FIG 15. ELECTRO-HYDRAULIC STATION, LES CLÉES-YVERDON. GENERAL SECTIONAL VIEW

at Dornberg, near Luzern, made by Bell, and many other undertakings, each of which in its design or arrangement shews progress of some material nature.

There might still be mentioned a number of improvements in hydraulic machinery, which are solutions of the problems set by modern conditions of operation, such, for instance, as the mechanical governors of Piccard & Pictet, whose remarkable efficiency secured to that firm the order for the first 5,000-horse-power turbine at Niagara, and one form of which is shewn in Figure 15, a section through one of the machines at the hydro-electric station of Les Clées-Yverdon. But these various constructions will not be further dwelt upon here, particularly as their adequate description would call for many detailed drawings, and only that phenomenon will be emphasised, which has been of the most far-reaching importance in the latest development of Swiss turbine manufacture, namely, the application of the modern Francis turbine, which was begun in 1894.

It is true that in the years 1855 and 1857, and later, the firms of Rieter and Escher Wyss built Francis turbines, owing, doubtless to the influence of Francis's celebrated work, "The Lowell Hydraulic Experiments," but, as may be proved by statistics, the number of the wheels built on this system was extremely small up to a very recent date, and they all lacked the characteristic mark of the modern Francis turbine, namely, the simultaneous movability of the guide-blades, which was proposed by Prof. Fink, of Berlin, in 1864-1866, and afterwards systematically developed by the firm of Voit, in Heidenheim, Würtemberg.

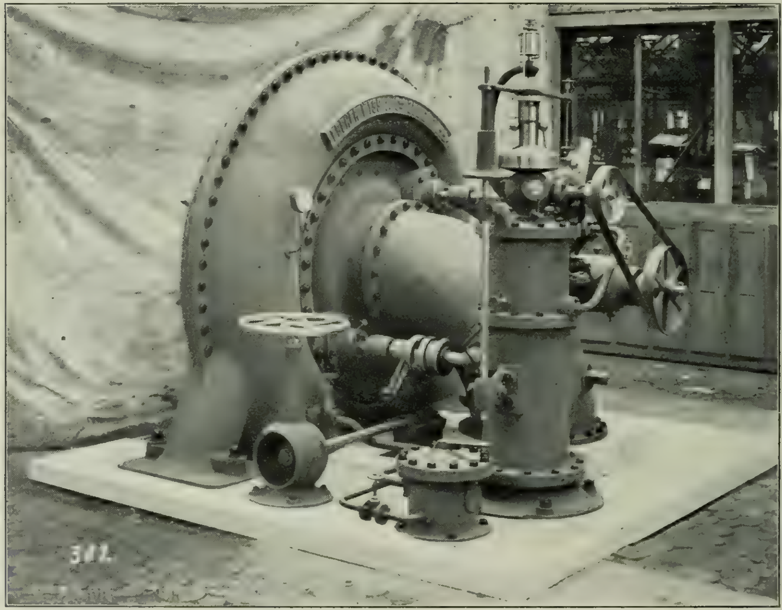


FIG. 16. ENCLOSED FRANCIS TURBINE WITH GOVERNOR.

Escher Wyss & Co., Zürich.

As may be established by simple calculation, the Francis design of wheel, other things being equal, requires the smallest dimensions, and also makes it possible to place a number of rings, one above another, so that a large flow of water is secured with a small diameter of wheel. When it was recognised what great advantages this turbine possessed where large capacity was to be combined with high speed, it was rapidly introduced. And as the knowledge concerning this wheel grows, through theoretical investigations and practical experience, it is seen that besides having a most favourable flow in the admission and discharge passages, the water chamber and the suction pipe, the Francis design secures that constant filling of all the turbine spaces with live water, even when the cross-sections are diminished, which is essential to high efficiency. This knowledge has led to the general adoption of the system.

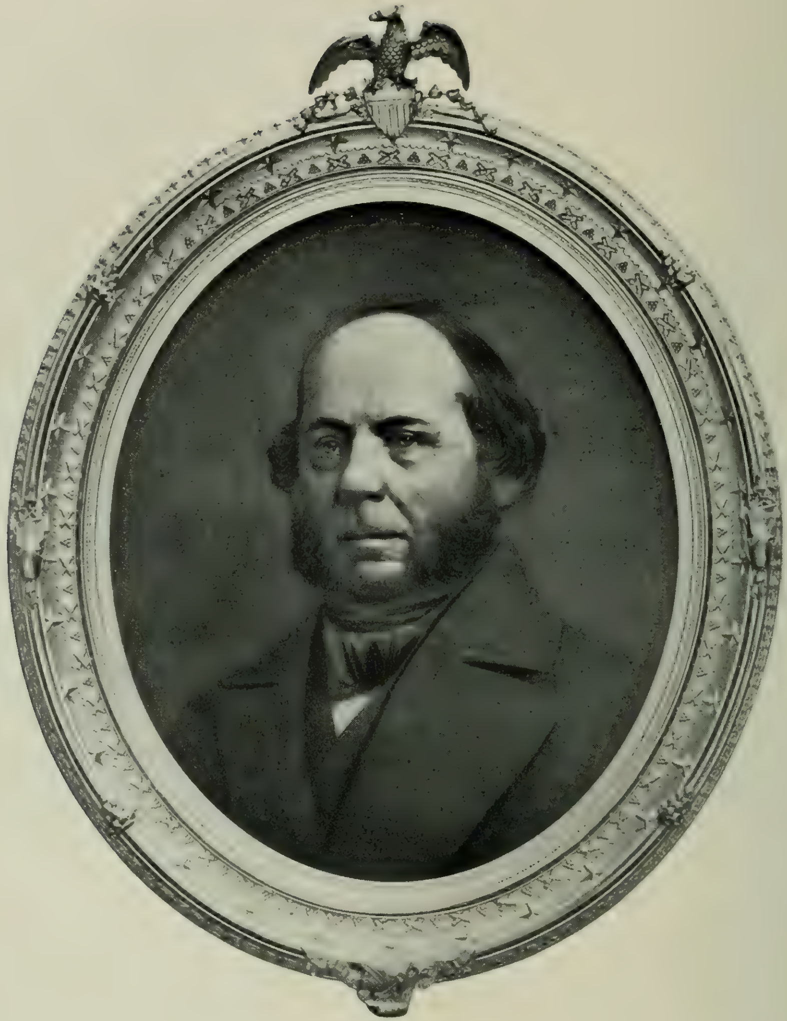
Since 1896, the manufacture of the modern Francis turbine has been taken up by nearly all the Swiss companies, and the victorious course of this system will be sufficiently indicated by a few statistics. Up to the year 1896 the old-style Francis turbines built in Switzerland had a total capacity of only 600 horse-power, while from 1896 to November of 1899, the number of new-fashioned Francis turbines, finished and under way, reached 210, with a capacity of 80,000 horse power. The system is used in all the more important new installations, with variations, it is true, depending upon the individual ideas of the constructors of the different companies.

With a keen appreciation of the adaptability of the system to the most widely differing circumstances, machines have been constructed which, with regard to economy in utilising the available energy, have reached the limits of possibility. As a case in point may be cited the 200-horse-power turbines which Escher Wyss have installed in the paper factory on the Sihl, whose efficiency, within wide limits of admission, reached the high figure of 86 per cent., according to thorough and careful tests made by me.

An example of such construction is shewn on the opposite page, Figure 16, as well as in the reports which treat of the turbines at the Paris Exposition, where this latest period of development was illustated in a striking manner.

It might almost appear that with such progress the problems of turbine engineering had been solved; this is, in fact, partly the case, and when, in the not far distant future, the great projects of Switzerland, which have for their objects the utilisation of about 120,000 horse power, shall be realised, they will be founded on the knowledge and experience gained up to the present day.

Nevertheless, it is probably true that the economic conversion of such great quantities of energy will lead to new problems, which today we anticipate as little as, but a short time ago, we understood the difficulties which, for instance, are connected with the operation of hydraulic motors when they serve as transformers of energy for electro-chemical works or standard electric railways.



CAPTAIN JOHN ERICSSON.

From an oil painting in the possession of the American Society of Mechanical Engineers, by whose courteous permission it is reproduced here. The painting was found in the shop of a dealer in second-hand goods, in Brooklyn, and purchased by the finder for the Society. A newspaper paragraph led to its identification by the artist, who happened to be passing through New York on his way home to Norway, as his own work, painted years before at the instance of a committee of Ericsson's admirers for presentation to the inventor himself. The intervening history of the painting is not known.

PERSONAL RECOLLECTIONS OF CAPTAIN JOHN ERICSSON.

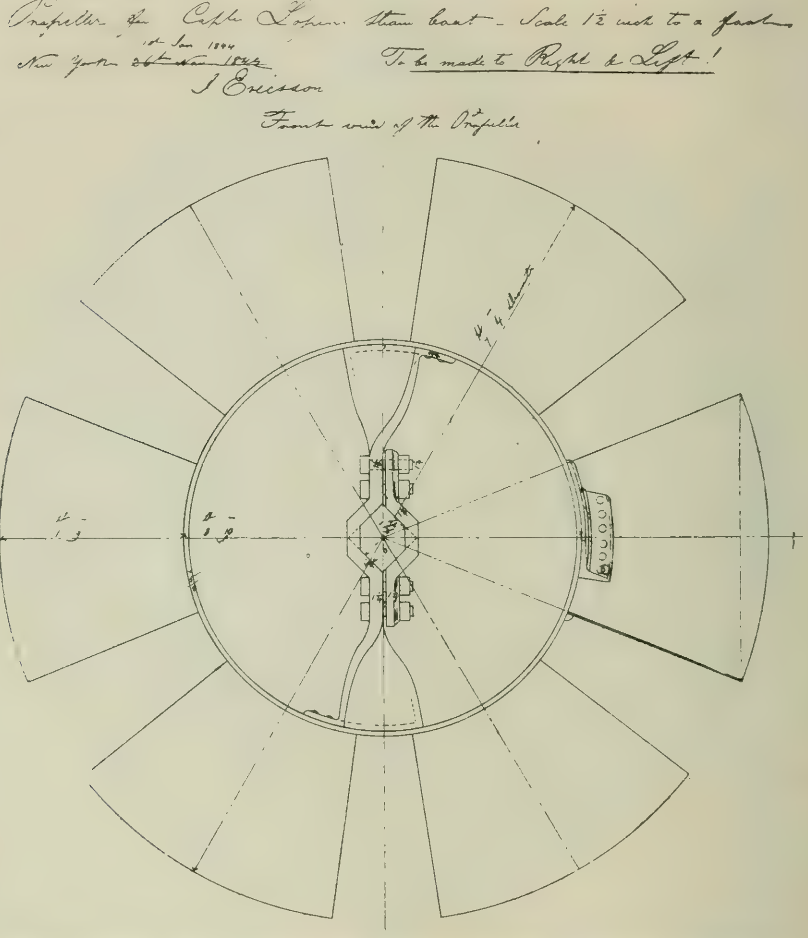
By Egbert P. Watson

The interest of personal memoirs of men who have strongly influenced the thought and progress of the world needs no argument. The reception given the biographical studies of Lord Armstrong, the Krupp family, Andrew Carnegie, and George Westinghouse, in our Works Management Number last January, proves how strikingly the man of action appeals to the modern world of action.

The accompanying sketch is of a somewhat different character, but is valuable in throwing a new light on the character and habits of thought of one of the most picturesque figures in a period of remarkable engineering change and progress.—The Editors.

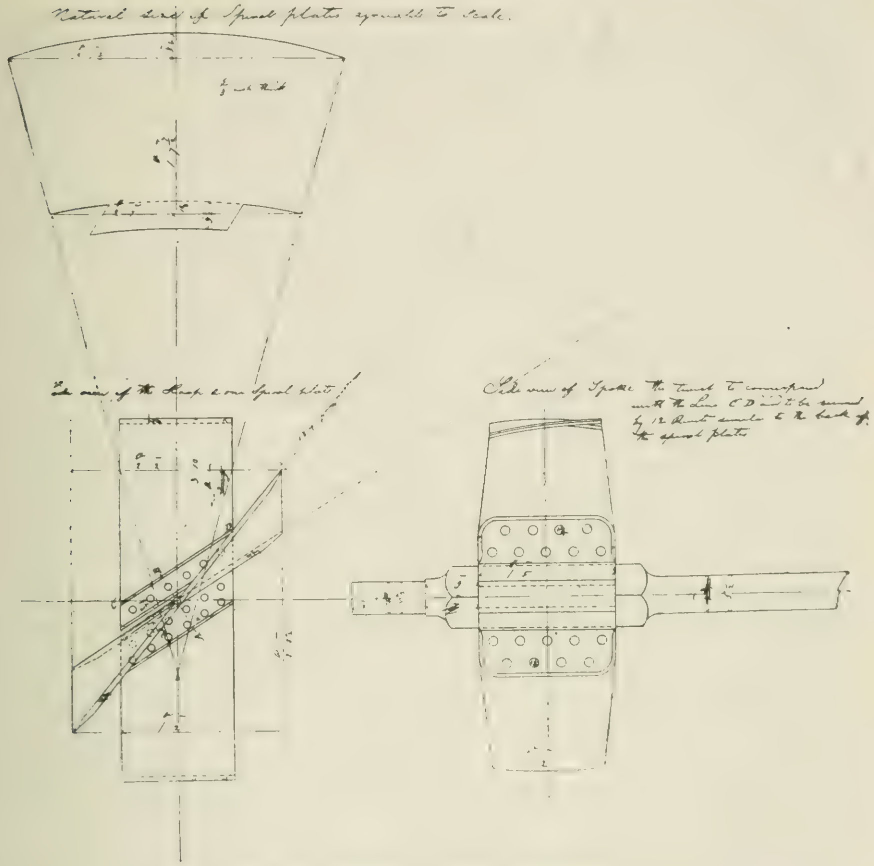
ONE of the most notable figures in the engineering world of the last century was Captain John Ericsson, best known to fame as the practical inventor and adapter of the Monitor type of war-vessel; for while he was not the first to propose a rotating floating armored gun-carriage on ship-board, he was certainly the first to put such a vessel under fire against an adversary. That claim has never been disputed successfully, and upon it some are disposed to rest his chief claim to the recognition of posterity, for it has to a great extent revolutionized naval warfare. Be this as it may, the man himself was scarcely less remarkable than his several inventions, not merely by his advanced views in matters appertaining to his profession, but in his personal characteristics, bearing, carriage, and general walk and conversation. He would have been notable any where and in any age for these differences from the average man. Even his personal appearance was striking. He was of medium height, very florid complexion, rather darker in tone than Europeans generally, with bushy black side whiskers. His address was abrupt, dictatorial, even domineering at times, and no one cared to enter into an argument of any length, or to advance opposing views, for that matter, after one experience. Captain Ericsson was of a robust figure, rotund in person and in voice, with an address which left no doubt whatever as to the meaning of his utterances. It cannot be said that he was an agreeable man to do business with; although he did not intentionally violate any of the canons of good breeding or good feeling, he was too much in earnest and too anxious to conclude whatever was under discussion to pay much attention to graces of delivery.

He could unbend and be genial upon occasion, but it was like a gleam of sunshine from a March sky and did not last long. With all these blemishes he was an extremely liberal man from a pecuniary point of view, but he insisted upon the absolute letter of a contract or a specification, and woe unto him who endeavored to evade one, unsanctioned by him! So insistent was he upon this point that in at least one instance a ludicrous thing took place. It was customary in those days to get the length of a piston rod the last thing, after the other details were in place. In pursuit of this object a draughtsman once went down into a cylinder with a long baton, and had hardly got


Propeller for Captn Loper's steam boat – Scale 1½ inch to a foot
New York 1st Jan 1844 ~~26th Nov 1843~~ To be made to Right & Left!
J Ericsson
Front view of the Propeller

REPRODUCTION, ABOUT 1/3 SIZE, OF AN ORIGINAL DRAWING OF CAPTAIN ERICSSON'S. DATE 1844.

Note the use of wrought and forged work, adapted to the possibilities of that time.


Natural size of Spiral plates reduced to Scale.
End view of the Hoop & one Spiral plate
Side view of Spoke the twist to correspond with the Line CD and to be secured by 12 Rivets similar to the back of the spiral plate

CAPTAIN ERICSSON'S SCREW PROPELLER.

Projection of the front view shown on the opposite page.

off of the ladder which led down into it when Captain Ericsson came on deck. Espying the draughtsman he said:

"What are you doing in my cylinder, Mr. Nelson?"

"I am getting the length of the piston-rod, Captain Ericsson."

"Have you looked on the drawing, Mr. Nelson?"

"No, sir."

"Come right out of that cylinder, Mr. Nelson. I will not have people going down in my cylinders with sticks for measures; go and look on the drawing, sir, and you will find the length of the piston-rod." This point he always insisted upon—that his drawings were correct, and if they were followed no loss would ensue. A workman once told me that he had a connecting-rod for a link motion to put up in which there were as many offsets as there are in a dog's leg, and that, try as he might, he could not get the rod in. He told Captain Ericsson of this and was asked if the rod was right according to the drawing; the man said that it was. "Then it will go in," was the reply, and after another trial it did go in.

For most of his devices he had models made to scale, showing the relative positions of the parts with accuracy; they were finely finished and put together, and drawings were made for them exactly as they were to be constructed; woe unto the model maker if he did not make every detail according to the drawing. If a fillet was omitted, or square-head bolts put in where hexagon-heads were indicated, the departure had to be rectified, no matter what it cost the model maker.

Captain Ericsson had his friends and his foes, as all mankind have; the former—when loyal—he rewarded richly, but for the latter, he simply defied them for all time. "I do not care what you do, sir," he said in my presence to one who opposed him; "I live for the truth, sir, and I will have what is right or nothing!" and he struck his fist down on a heavy rosewood table with such force that a large cut-glass inkstand jumped about six inches.

It was through a singular train of circumstances that I first came in personal contact with Captain Ericsson, and enjoyed his personal acquaintance. When the American civil war broke out I was employed in the Novelty Iron Works, where the original Monitor was fitted with its turret. This, as is well known now, consisted of a series of plates bolted together by through bolts, one-inch diameter; being detailed to make a reamer to true the holes, I did so and tried one bolt to see if it fitted properly, thus driving the first bolt in the turret. Shortly after I was employed upon the *Scientific American* as associate editor, and being thoroughly familiar with the Monitor construction, defended her plans and principles from all and sundry who attacked them, and in those days there were plenty of assailants. After possibly six months of this warfare, I received notice that Captain Ericsson desired to see me and it was with no little trepidation that I set out to keep the appointment. Captain Ericsson lived and died at No. 36 Beach street, New York, a part of the city, just out of West Broadway, that had once been of great pretensions, but had then fallen very much in public esteem. The surroundings were poverty-stricken, and even squalid in appearance. The basements of the still handsome houses were tenanted by green grocers, rag and bone "merchants," junk-men, and charcoal peddlers. The windows were tenanted by frowsy cats dozing in the sun, while through the wide-open hall doors troops of shouting boys raced incessantly. I had some doubt as to the correctness of the address given, but kept on until it was reached and found it. Scarcely had I delivered my card and been ushered in to the front parlor when a noise was heard as of a ton of coal being violently thrown down stairs and Captain Ericsson rushed in holding out both hands. He said, in a voice like one hailing the main-top in a living gale: "You are Mr. W.! I am very glad to see you, sir; you have done me a great service, sir: Wait here, sir, I am very busy indeed!" and away he sped out of the room with the agility of a youth of twenty. Back he came in a very short time with a long yellow envelope which he thrust into my hand, saying, "Take that with my compliments, sir: I am very busy. Good morning, sir!" and ushered me out without further ceremony.

The whole interview was, as one may say, extremely abrupt, my part in its being confined to saying "Yes, sir" and nothing more. Safe outside of the door, I carelessly tore open the envelope, thinking it had papers referring to the Monitor, when, to my consternation, five $50 Treasury notes slid out on to the sidewalk. Being convinced that a mistake had been made, that in the haste of the moment the Captain had picked up the wrong envelope, I lost no time in ringing the bell again, with a request to see Captain Ericsson. He came down as before, in a moment, greatly perturbed in manner and speech.

"What is the matter now, sir?" he demanded. "Why have you called me down again?"

"Captain Ericsson, there is money in this letter, I thought it possible that you might have made a mistake!"

"No, sir; there is no mistake, I do not make mistakes; nobody shall do me a service but what (sic) I shall pay him: Good morning, sir!" and he promptly thrust me out upon the door step again. Lost in speculation as to what manner of man it was that did business in so brusque and abrupt a fashion, I went back to my avocations and reported that Captain Ericsson had made me a present, omitting any details as to the amount of it. I was told to pocket all such insults, as mere business details. A repetition of the same affront from Captain Ericsson some weeks later did not seem to require a report.

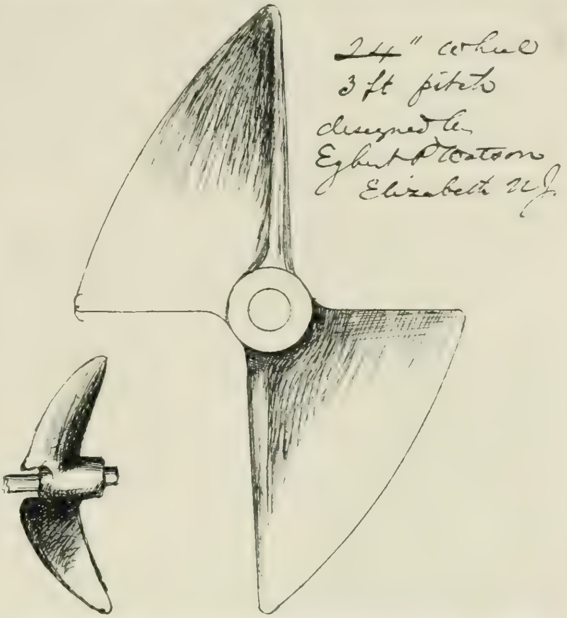
This incident may seem trivial to the reader, but it is so characteristic of the man and his methods that it is worth recording. He could, however, use far different methods with those who sought to get money from him by disreputable means. No one was shrewder than Captain Ericsson to detect at once any attempt to swindle him. At a subsequent interview, also connected with the Monitor, Captain

Ericsson came into the room in the stormiest of humors. "Where you sit now, sir," he said, "a damn rascal tried to make me pay hush money; he said he was the son of a clergyman, was a reporter upon the New York ——, and knowing that a leader was about to be published unfavorable to the Monitors, he thought it best to show me a proof; his principles would not allow him to take what he considered an unfair advantage of his position. Do you know what I said to that infernal scoundrel, sir?" (towering over me like an incarnate spirit of wrath) " 'Suppose I do not wish to have it published,' I said, 'what then?' 'In that case it will cost $1,000 to suppress it,' the fellow told me. 'Go and publish it at once, sir. I do not care what lies you publish; it will be all lies; you know nothing about my vessel, sir. I live for the truth, but you have no truth. Get out of my house at once, sir! I will not have such a rascal as you are in my presence!' " There is no doubt but that the order was obeyed.

Captain Ericsson was not a vain man, in the ordinary sense of the word, and gross flattery or fulsome adulation was as irksome to him as it is every man with common sense; but he knew the value of his professional work, and anyone who was capable of appreciating it was his friend. He was quick to see the value of the discoveries of others also; provided they were orthodox in construction and in intention he supported them, but he had little mercy upon those who were mere revampers of the ideas of others.

He was years ahead of his time in engineering, and was always a student along all lines of it; especially did he delight in new mechanical movements and combinations, and his adaptation of them to the end sought was always striking, though possibly not always elegant. John Ericsson was among the first to see the advantages of the screw as a propeller of vessels, and the history of the introduction of it and the first experiments with it are examples of his faith in it. This last strengthened as he grew older, and the "Delamater screw," so long used in days now past, was designed by Captain Ericsson, though built at the works above named.

Like many others, I once conceived that I had devised a new idea in screw propellers, and to test it built a small working model of a launch. This model was 48 inches long by 6 inches beam, and had about 10 pounds displacement. It had an engine and boiler which weighed 5 pounds, and the boiler, or boilers, were only 2 inches diameter by 12 inches long, so any desired pressure could be carried on it. Upon trial the conception worked very well indeed, and, full of the idea of a speedy fortune, I was emboldened to ask Captain Ericsson's opinion of its commercial value. It was not easy, or agreeable either, to undertake this, for Ericsson was at all times beset by inventors to view their plans, and also to endorse them; he said that if he consented in one instance he would have to in others, and his time would be so taken up that he could not do anything else. Nevertheless he did consent, in my favor, and by appointment the model was taken to Captain Ericsson. He looked at it carefully all over for some time without remark, but finally said: "What are you trying to do, sir? Do you know what you are trying to do? Look at this" (striding rapidly across the room and laying his hand on one of the large mahogany doors) "a screw with no more area than this will drive a ship of 3,000 tons all day and forever, if you keep it going; how can you beat that? Do you think you can beat that? No, sir; you cannot beat it; your screw is not worth a damn sir; I don't care what shape you make the blades, you cannot beat a true screw."



SKETCH OF FISH TAIL SCREW REFERRED TO BY MR. WATSON; DATE ABOUT 1875.

"This is a true screw, Captain Ericsson," I ventured to observe.

"Oh! is it; I thought from the appearance of it it was some kind of a mongrel pitch!"

"No sir; the shape of the blades is governed by the principle of the wheel, and is merely incidental."

"All that is nonsense, sir; I do not care what shape the blades may be so long as you have a true screw as regards the pitch. If it is, as you say, a true helix, you have just as much but no more than the present screw, in which event you have nothing more than exists now."

There was no appeal from this verdict, and as I had invited criticism, and obtained it, I had to be content with it. Captain Ericsson then inspected the model more closely and inquired what speed had been obtained from it, and when told that it was three miles an hour by the watch for a short distance, said, "My! you have done a great thing, sir; I never could get half that speed with a model."

"Perhaps not, sir, with clock work, but this engine has worked under 200 pounds per square inch, and makes at least 2,000 revolutions per minute."

"How do you get any such pressure as that?" said Captain Ericsson.

"With oil fuel and by 'bottling her up,' as it is called."

"Oh, ah! that is possible then," and there the subject was closed.

It has been said elsewhere in this article that Captain Ericsson was ahead of his time in engineering investigation and practice; this is true as regards the comparatively recent advance from low boiler pressures and few expansions to high boiler pressures and many expansions. In the later years of life he gave this matter more attention than he had in earlier years. There are fashions, as one may say, in all directions, and high expansion was, and is for the matter of that, the question of the day.

Captain Ericsson was not a believer in the necessity of multi-cylinder engines to obtain economical high expansion, declaring in so many words that they were only devices of English engineers to make more work. He asserted that higher economy and better results all round could be had in two cylinders than in triple or quadruple cylinders, and he designed a two-cylinder high-expansion engine to embody his views, and to prove or disprove them. It was, in appearance, an ordinary tandem-compound horizontal engine, but it had a much higher ratio of cylinders than any engine built prior to it had. The high-pressure cylinder was 8 inches diameter, the low pressure 32 inches diameter, by 24 inches piston stroke; a nominal number of expansions would be, reckoning from initial to terminal pressures, twenty-four, but I was informed that the actual expansions shown by indicator cards was nearly thirty-six. The usual number of expansions for an engine of the size named would have been eight. The boiler pressure was 200 pounds per square inch. With a consideration which was highly appreciated by me as a personal compliment, Captain Ericsson sent a special messenger to say that he desired me to be the first one to see the engine in action in the Delamater works, where it was built—after the constructors, of course—and I took immediate advantage of the opportunity. The valve-gear, outside of the extraordinary cylinder ratios, was the most remarkable feature. It had a gridiron slide-valve operated by a sword arm on the main shaft so quickly that the exact point of cut-off must have been difficult to ascertain; it literally snapped the full boiler pressure onto the piston as a bullet is fired from a gun. It has been asserted repeatedly that this method of induction could not be used practically, owing to the great shock on the details, but this engine worked as quietly and as smoothly as any engine with a common valve-gear. It continued so to work for several months. For duty it drove a screw propeller in an enclosed tank, and showed a higher economy than any engine within my knowledge had shown up to that date—about 1884-86. The tabulated results, as shown by carefully worked-up indicator cards, gave under twelve pounds water per horse power per hour, as against eighteen to twenty pounds for ordinary two-cylinder compound engines, and fourteen to sixteen for triple and quadruple-cylinder engines. Its mechanical action left nothing to be desired. This engine is still in existence, or was a short time ago, in custody of the trustees of Captain Ericsson's estate; an attempt was made shortly after his death to put it on the market but it came to nothing.

Captain Ericsson was a most indefatigable worker all his life; it may be said of him literally that he dropped his pencil only to die. After he was 83 years of age he sent his secretary to me with a pencilled drawing to show that his cunning had not departed from him. When his physician had at last made it clear to him that his work was done (at nearly 84 years) he was unreconciled, and his last words were in connection with his work: "Have I got to die?"

Captain Ericsson made a great deal of money in his profession, but he also spent a great deal in many directions, and at the close of his career had little or nothing to show for it except his record. His bequests to those who had served him in any capacity for years—members of his household and professional assistants—were munificent, but when the trustees came to realize upon the assets they shrunk to insignificance. For years Captain Ericsson had a large income from his hot-air pumping engine, but for the Monitor type of armored vessels he never received a penny from the United States.

This brief transcript of my acquaintance with Captain Ericsson is in no sense a memoir, but embodies only the salient points of my knowledge of one who was, in all senses of the word, a most remarkable man. As much has been omitted as has been set forth, but what has been given will perhaps show a different side of Captain Ericsson from the generally accepted idea of him.

ACTUAL EFFICIENCY IN STEAM GENERATION.

By A. Bement.

In every branch of productive activity, empiricism is giving way to methods based on exact knowledge. Mr. Bement shows how, in the initial operation of power development—the realization of the latent energy in the fuel—engineering and chemistry may work together in perfecting practice.—The Editors.

SPECULATION concerning the heat efficiency of steam boilers and furnaces is active enough, but there is a confusion of ideas and opinions leading to no logical explanation of the matter. This is largely owing to the fact that the chemical process in the furnace and its relation to and effect upon the efficiency of the steam-generating apparatus have not been taken into consideration. The mechanical engineer controlling the design and operation of furnaces and boilers, not being a chemist as a general rule, has relied upon the data furnished by physical evidence for an explanation of the phenomena, while the chemist on the other hand, from lack of experience and knowledge of the physical conditions, is at a decided disadvantage. An understanding of the chemical features of the problem is essential to its examination, and in addition thereto, the proper method of manipulation in operation must be studied from this standpoint if good results are secured.

One of the conditions having an influence on efficiency has more or less generally been supposed to be the number of pounds of coal burned per square foot of grate per hour. It has been contended by some that the combustion of a small number of pounds was conducive to better results than if a larger number were burned. Tabulated results and data from experiments have been offered, showing that as the pounds of coal burned per square foot increased, the evaporation per pound of coal decreased; but, on the other hand, data have been submitted showing the opposite result, and very often in boiler trials it has been found that the most water was evaporated per pounds of coal when the horse power developed was much in excess of the rated power. The amount of coal burned in a given time has an important bearing on the performance, but the amount burned per square foot has no significance, because there is no standard grate area. The ratio to that of heating surface may, and does, vary from 1 to 30 to 1 to 90 in different cases and varying kinds of service, and if the number of pounds of coal burned per hour per square foot of grate is to be taken as affording any evidence of effect on efficiency, it could apply only where other conditions were the same—as, for example, in different experiments with the same grate and heating surface. The better way would be to state the total pounds of coal burned in the hour. This leads to the effect on efficiency of the temperature and quantity of the gas which may pass from the furnace, and also of complete or incomplete combustion.

The work of the furnace is to oxidize carbon to CO_2 and hydrogen to H_2O. These gases and the nitrogen, together with the unused air present, serve in a measure as the carrier of the heat generated, and it is desirable not only that the combustion shall be complete, but that the volume of the gases be as small as possible, because their temperature will be governed by their volume. If the volume is large, the same amount of heat, distributed throughout the larger mass, will produce a lower temperature; further, the amount of heat carried away by the gases will depend on the volume of these gases escaping from the boiler. For these reasons the temperature of escaping gases has no significance whatever, unless their quantity is known—just as, with a quantity of water, the heat contained would not be shown by the temperature alone; the number of pounds must also be known.

The initial temperature of the gases at the furnace is important because the transfer of their heat to the boiler will be governed by the difference between their temperature and that of the boiler. Therefore, as the quantity of gases is smaller, the furnace temperature will be higher, the heat transfer to the water will be greater, and as a result, the gas will pass from the boiler at a lower temperature. The efficiency will be greater because there will be less actual heat units in the escaping gas. The volume of the escaping gases is probably neglected more than any other feature of the problem, but when it is realized that under most favorable conditions the air supply in weight cannot be less than twelve to fifteen times that of the coal, and may and often does actually exceed fifty or sixty times, the effect of the quantity of air is seen to be of supreme importance.

If some of the conditions of operation are examined, many of these features will be illustrated. To this end it may be assumed that the completeness of combustion bears a constant relation to the air supply; the volume and weight of gas would then be in constant ratio to the weight of combustible. Under these conditions, as the amount of coal burned *in a given time* is increased, the temperature of the escaping gases rises and the efficiency falls, regardless of the rate of combustion per *square foot of grate.* This condition is best defined by saying that, other things being the same, as the quantity of coal burned in a given time increases, the efficiency decreases, or as the coal decreases, the efficiency increases, because a given amount of heating surface will better cool the smaller amount of gas evolved.

With the same amount of coal burned to complete combustion, the efficiency will decrease as the air supply increases; this is because the volume of gases increases, and not only their volume, but their final temperature will increase; this latter condition is caused by a lower furnace temperature, which, together with the greater volume, presents a cooling problem of greater difficulty for the boiler.

With constant amount of fuel burned to complete combustion, and with very large air supply, the efficiency will be correspondingly low; as the air supply is reduced the efficiency will rise to a maximum, which will be reached at minimum air supply for complete combustion.

Starting with an excessive and uniform air supply, the efficiency will increase as the amount of fuel burned increases, and the relative volume of gas per unit of fuel will decrease. While the relatively smaller volume of gas in the first instance yields lower temperature of escaping gases, the increasing amount of fuel burned causes an increase in temperature, and the greater efficiency is due to a much reduced proportional volume of gases.

With a condition approaching incomplete combustion, and an increase in the fuel supply or a reduction of the air supply, the efficiency of the steam-generating plant as a whole will be less; the temperature of escaping gases will be lower. Under these conditions, the resultants are higher initial temperature, smaller volume of gases, and lower final temperature; but with these conditions the efficiency of the boiler proper increases, because the work of the boiler is to absorb the sensible heat of the gases, and therefore, as the furnace efficiency drops rapidly on account of incomplete combustion, the boiler efficiency rises slightly. It thus appears that the final temperatures are of no significance, unless considered in connection with the conditions of combustion, or the relative constituents of the gas.

Circulation of the water in the boiler is frequently credited with a very large and important effect on efficiency, cases having occurred where large incomplete-combustion losses have been charged to this cause. There is no doubt that circulation has some influence on heat transfer, just as has an unclean boiler, but these influences are certainly over rated; because if there is a large amount of the heat of the coal not accounted for in the steam, in sensible heat in the gases, radiation, etc., it must either exist as latent heat in the gases from incomplete combustion, or be stored in the metal of the boiler. If the latter is the case, it would not take very long to heat the boiler to a temperature that would insure its destruction. A case coming under my observation is of interest in this connection; it was that of a forced-draft furnace where the requirements were for a good efficiency at rated power of the boiler, and ability to attain a maximum of double the rating. On a trial at rated power the performance in pounds of water evaporated per pound of coal was quite satisfactory, but with the effort to attain large power, although all the coal was fed to the furnace that it would take, the horse power was about 3 per cent. less than on the first experiment. The excess amount of coal used in the second experiment was more than sufficient to melt the entire boiler and to heat all of the brick work red-hot. This boiler had previously been worked at a rate of a horse power for each five square feet of heating surface with perfect ease, but with another furnace. In this case the trouble was that the limit of the air supply had been reached, at rated power; and this illustrates one of the features that gives mechanical draft an advantage, which is, that it is not what it is usually considered to be, a scheme for large air supply, but is, in fact, the opposite, and for this reason suits usual prevailing conditions of stationary-boiler practice where the tendency is for too large air supply.

The diagram, Figure 1, shows losses in hot gases with varying air supplies and complete combustion. It is apparent that with a very good condition as illustrated by 15 per cent. CO_2 the loss is about 2½ per cent. for each 100 degrees F. rise in temperature; with 8 per cent. CO_2, 5 per cent.; and with 4 per cent. CO_2, about 10 per cent. If it is assumed that an economizer would reduce the temperature of gases 200 degrees, then its application under conditions with 15 per cent. CO_2 would result in a saving of 5 per cent.; of 10 per cent. with 8 per cent. CO_2; and of 20 per cent. with 4 per cent. CO_2. The best opportunity afforded the economizer is with such condition as illustrated by 6 to 8 per cent. CO_2, because with the poorer conditions the efficiency of the combination would be so low as to be unsatisfactory whatever the performance of the economizer might be.

The engineer or the expert, may, after trial, certify to the evaporation of a certain number of pounds of water per pound of coal, or to a certain percentage of efficiency which may be entirely satisfac

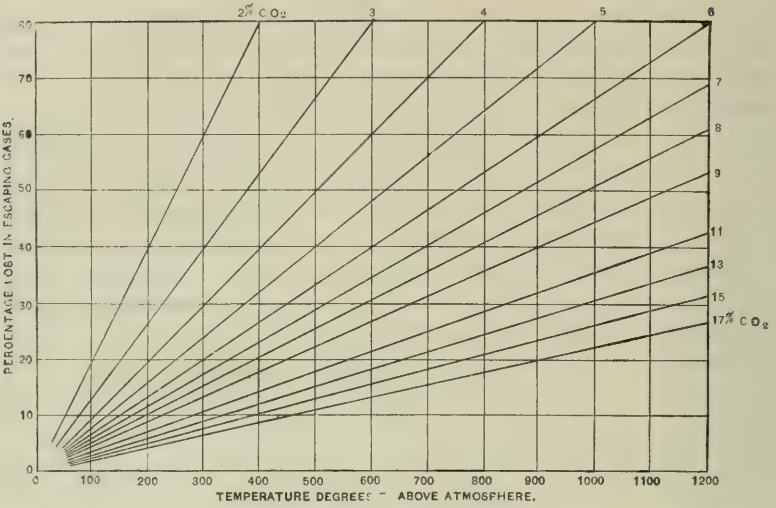


FIG. 1. LOSS OF HEAT WITH COMPLETE COMBUSTION AND VARYING AIR SUPPLY.

tory; but a steam-generating apparatus is expected to perform service for several years, and its efficiency during this time is of vital importance, and if it is a fact that in everyday performance the trial results are repeated, then the owner is assured that economy in coal consumption is obtained. I should gather the impression that the opinion is quite general among owners, especially in the United States, that because the performance on trial was good, or because they had purchased standard apparatus, they were getting economical results in everyday work. As an almost universal fact, however, nothing could be further from the truth.

There are two conditions which must be complied with, or economical performance will be impossible; the first is complete combustion, and the second minimum air supply; and these conditions must not only occasionally be secured, but must be maintained as regular practice. That these are conditions that are *not* generally complied with, cannot be stated with too great emphasis, as evaporations of from one to four pounds of water per pound of coal are actual performances in a good many cases, and everyday efficiencies of from 25 to 50 per cent. are rather the rule than the exception.

There are several things that conspire to keep the owner in ignorance regarding these facts. One is, that published records of trials lead him to assume that, because the efficiency of a steam-generating apparatus is given as 70 to 85 per cent., this performance is necessarily an inherent characteristic of the apparatus. Nearly all trials of importance are made to show fulfillment of guarantees, and often, if the results are not satisfactory, other experiments are made, or a more skillful expert is called in, who understands how to harmonize the matter of complete combustion with minimum air supply and low temperature of escaping gases, with resultant exhibition of a high efficiency. It would be of great value if the results of preliminary trials were fully reported; likewise, if experiments were made to ascertain how low an efficiency could be secured, such data would be of more value than many of the trials for high results.

In one way the furnace maker is to be blamed, because he does not impress on the purchaser the importance of careful and intelligent manipulation, and the realization of the fact that satisfactory performance can be secured in no other way. In my acquaintance there is only one furnace maker who gives this feature due prominence. It must be said on the other hand, however, that the purchaser is usually looking for something that requires no skill to operate, and which promises to go right of itself, and if a furnace maker emphasizes the importance of skillful working, he is in danger of losing a customer to some other maker who is willing to cater to the purchaser's ideas.

Often an engineer will weigh the coal and measure the water evaporated, with the object of ascertaining the economic performance of his plant; but the method pursued is calculated to defeat the object, because he is likely to detail his best firemen for the work, and the man will himself endeavor to do as well as he knows how, either for his own credit or because he is imbued with the idea that an experiment of this character required much greater care on his part than is necessary in everyday work. The result is a performance which is very much better than the average.

It is, indeed, a difficult matter to ascertain how bad a performance may be, because as soon as the fireman sees that he is being watched he is sure to improve his practice, and any preparation toward weighing coal or measuring water is at once an incentive for him to do his best. The method best suited to secure evidence of every day conditions is testing the products of combustion, and if provision is made so that this may be done when the fireman is not aware, some surprising conditions may be discovered.

Illustrating this point, Figure 2 will be of interest. It shows the percentage of carbon dioxide, plotted from indications of an econometer at the time some experimental work was under way, while the man supposed that gas was being taken from some other boiler; upon

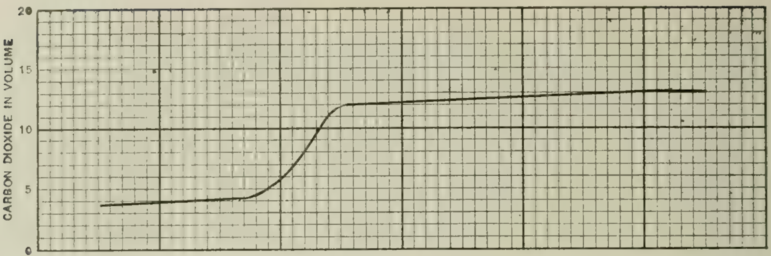


FIG. 2. RISE IN EFFICIENCY OF FIRING UNDER THE SPUR OF OBSERVATION.

his discovery that his work was being observed, the character of combustion changed as shown by the rise in the curve, from 4 to 13 per cent. CO_2, with a reduction of loss of about 32 per cent. In this connection Figure 3 shows the prevailing CO for one hour in another case.

Where there are a number of boilers of uniform size each fitted with a furnace of the same capacity, the impresion likely to be given is that there would be a similarity in the amount of work from each. Figure 4 shows samples of performance of this kind. The curves A, B, and C, show various average amounts of water evaporated per man and per boiler for three different days; the record A being first taken, it is plotted in the order of decreasing pounds; the two other curves are governed in their formation by the order of men as arranged in A. It will be observed that while some of the points of the three curves show an approximate agreement in pounds of water, others are widely different. There is a difference between the highest and lowest horse power of 46 per cent., and in efficiency the difference was not less than 30 per cent. It should be stated that the performances shown by Figures 2, 3 and 4 are not selected from sources where the conditions and practice would be expected to be bad, but from plants in which results much above the average are secured.

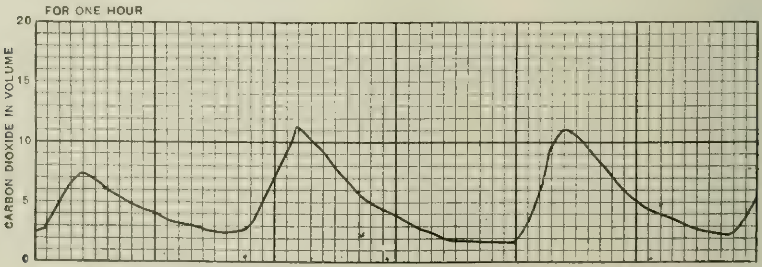


FIG. 3. PREVAILING CO_2 IN AN HOUR'S FIRING.

Very large savings can be effected by improved management and methods of operation, and this will be best secured through study of conditions of combustion. Loss by bad conditions is quite often attributed to what is designated as incomplete combustion, and incomplete combustion, as far as carbon is concerned, is its oxidation to carbon monoxide. Diagrams 5, 6 and 7 will explain this feature, as well as the effect of volume and temperature. These diagrams, for simplicity of illustration, are based on the assumption that the fuel is carbon, and the conditions are carried to the theoretical; for example, complete combustion with no excess of air with all of the carbon accounted for in CO_2, and also all of the carbon accounted for in CO, with no air present.

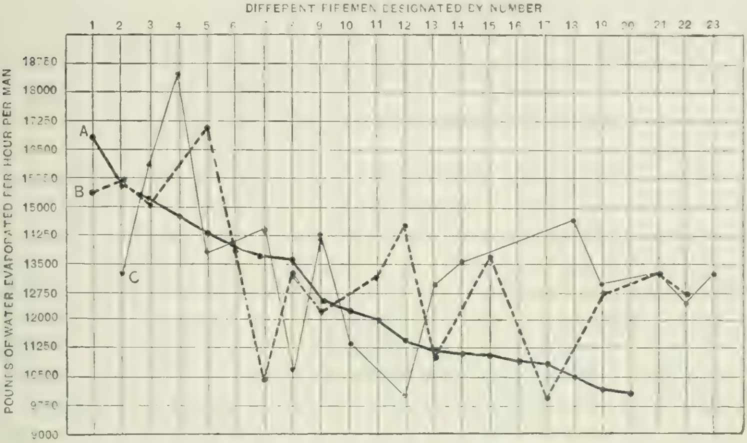


FIG. 4. EFFICIENCY RECORDS OF VARIOUS FIREMEN.

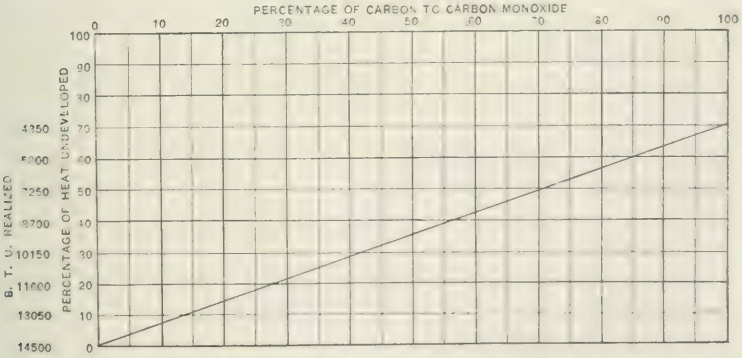


FIG. 5. LOSS OF HEAT WITH CARBON CONSUMED TO CARBON MONOXIDE.

Figure 5 shows a loss of 70 per cent. with all of the carbon burned to CO, consequently there is available only 30 per cent. in the gases as sensible heat for the use of the boiler. This shows the incomplete-combustion loss at its theoretical maximum.

Figure 6 presents curve of loss with varying air supplies and constant final temperature of gases, also the theoretical minimum air supply for complete combustion and a range of final temperatures. With combustion of all the carbon to CO, there being available for the use of the boiler 30 per cent. of the heat, if it is assumed that of this the boiler will absorb the conservative amount of two thirds, then the efficiency under these conditions would be 20 per cent. and the loss 80 per cent.; while with the opposite condition, that of complete combustion with the gases at the low final temperature of 400 degrees, the loss could also be 80 per cent. The small loss with extreme range of final temperature to 1,200 degrees, but with an ideal condition of

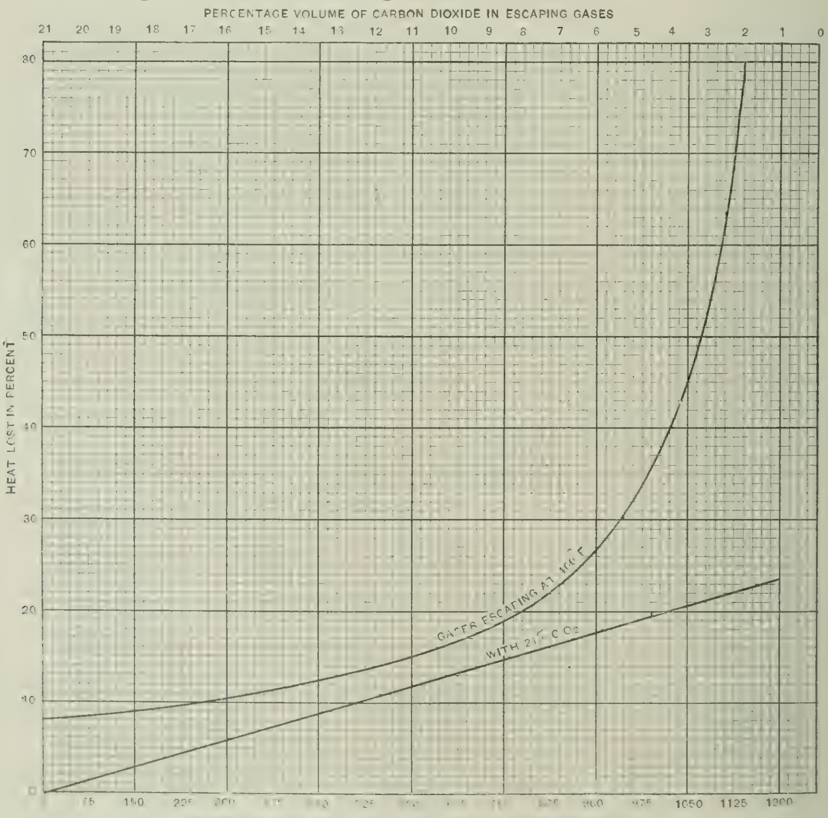


FIG. 6. LOSS OF HEAT EFFICIENCY WITH VARYING AIR SUPPLY AND CONSTANT FINAL TEMPERATURE.

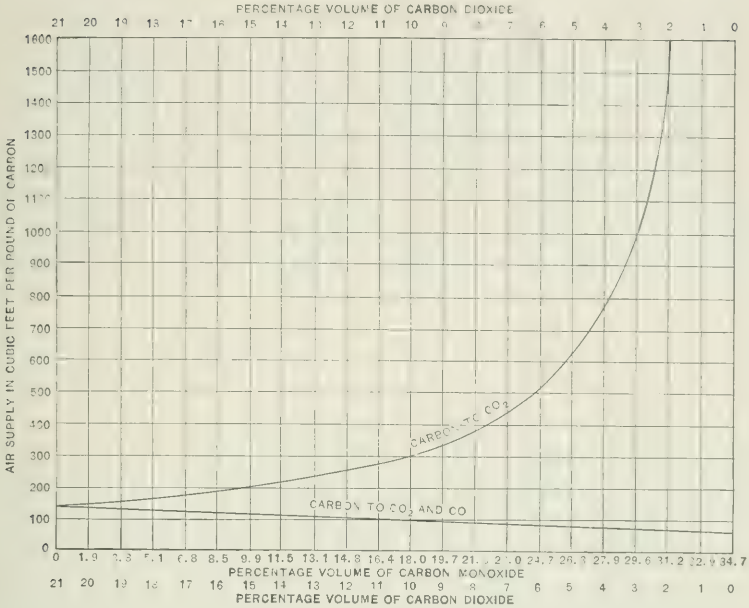


FIG. 7. EFFECT OF VOLUME OF AIR SUPPLY ON COMPLETENESS OF COMBUSTION.

combustion, is most significant in comparison with that shown by the other curve above it at only 400 degrees.

Figure 7 serves to show the volume of air supply with the conditions of combustion presented; the upper curve illustrates why there may be a loss of 80 per cent. at 400 degrees, while the lower curve shows the condition which causes low final temperature with incomplete combustion. This assumed condition must necessarily be one with no unused air, because all oxygen present would combine, and if in excess of the requirement for theoretical maximum volume of CO, would prevent its attainment.

Owing to lack of understanding, many boiler owners not only allow wasteful conditions to continue, but are led into unnecessary and extravagant investments, supposing that they are replacing apparatus with other of superior character. A furnace maker or his agent who is able to make a fairly correct estimate of the losses caused by bad practice and management, will offer to install his furnaces to be paid for if a certain percentage of saving is shown on trial by his apparatus, which will be operated with all of the skill at his command; the result often is that the purchaser discards old apparatus for new, when, if he had improved his practice, he might not only have obtained just as good results, but have saved a large investment cost.

THE MECHANICAL EQUIPMENT OF THE SHIP-YARD.

By Prof. J. H. Biles.

Professor Biles' initial paper was published in the preceding issue of THE ENGINEERING MAGAZINE. In it he dealt with the influence of equipment on the cost of ship-building, the classes of machines required and their arrangement in the plant, the structural work of a ship and the operations involved in its building, and the tools used chiefly in the work of framing.

The discussion following is addressed chiefly to the tools employed more particularly in working, shaping, and fastening the plating of a ship. The unusual space requirements of the illustrations make it necessary to leave the pneumatic tools and appliances for inclusion in the last of Professor Biles' articles, which will be published in our July number.—THE EDITORS.

THE tendency of late years to use plates of as great a length as possible has involved the installation of larger tools for the various processes of their preparation for the ship. At the present day, plates 30 feet in length are not uncommonly used, especially for the larger class of work. The economy of using broad plates has already been discussed under the question of punching machines, and the same remarks apply to long plates. A better and more efficient arrangement of butts in the shell or decks of a ship can be obtained by the use of large plates. Against this must be placed the extra cost per plate of handling due to the greater weight, but in a well-equipped and well-arranged yard, where the amount of manual handling is reduced to a minimum, this item does not assume very large proportions and is off-set by the reduced number of plates to be handled.

Plate bending rolls are now in use in all the larger shipyards. Illustrations are shewn in Figures 22, 23, 24, and 25. This machine is generally the most expensive in a shipyard, costing as much as £5,000. The main part of this machine consists of three strong rollers, two at the bottom and one at the top. The height of the top roller can be altered. The axes of the bottom rolls are fixed in position, but the rolls can be driven in either direction by a reversing engine. In bending a plate, a mould is made to the required shape, or two or three set irons are curved to the required shape at definite parts of the plate. The plate is inserted between the rolls, which are driven round. The

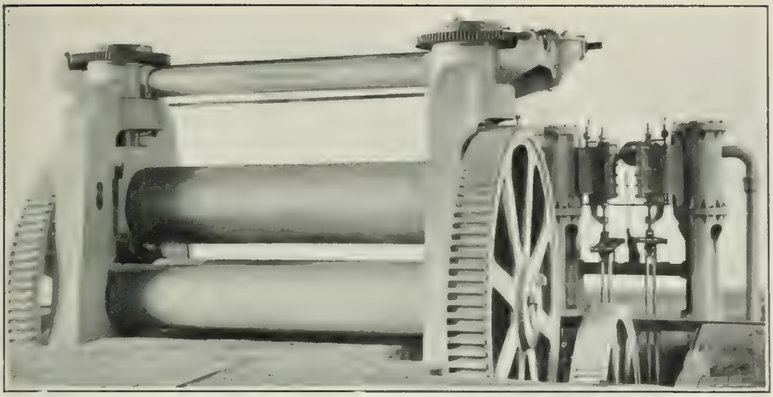


FIG. 21. PLATE-BENDING MACHINE.

For steel plates for gun shields, etc., up to 11-feet wide and 5-inches thick, when hot, and up to 3-inches thick when cold. Top roller is raised and lowered by steam engines. Driven by pair of steam engines with link reversing motion. Scriven & Co.

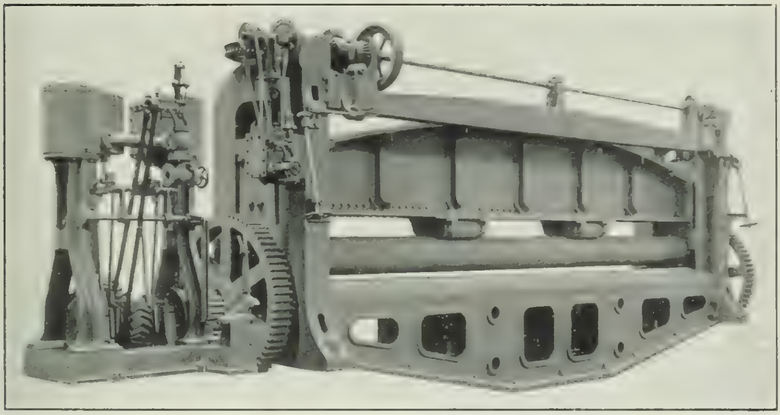


FIG. 22. SHIP-PLATE BENDING ROLLS, ENGINE DRIVEN.

For bending plates up to 35-feet long and 2-inches thick. Two pairs of supporting rollers. Hugh Smith & Co., Glasgow.

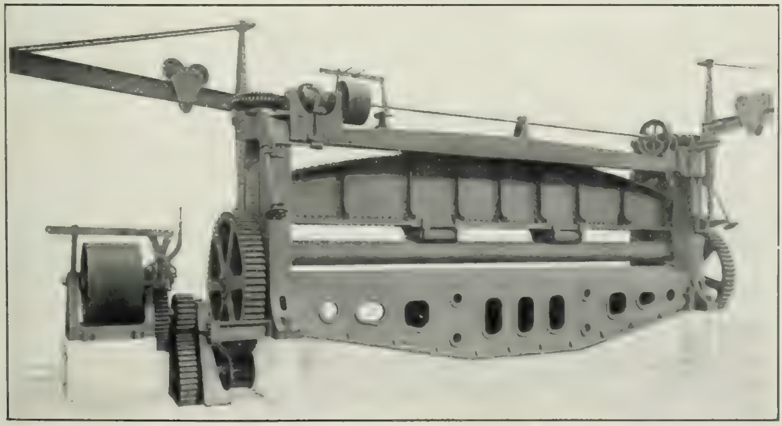


FIG. 23. ROLLS OF THE SAME GENERAL TYPE AS FIG. 22, BUT DRIVEN WHOLLY BY BELTS. ONLY TWO PAIRS OF SUPPORTING ROLLERS.

top roll is then lowered so as to give the plate a slight bend at first. When the plate comes out at the other side, the curvature is tested by the set-iron moulds so that the workmen know how to alter the top roller for the next roll, which is given by reversing the engine and sending the plate back through the rolls. This process is repeated until the plate has the required amount of bend.

Figure 21 shews a powerful set of bending rolls driven by a double-cylinder reversing engine, and having an independent engine for working the elevating gear of top roll. The framing for this machine requires to be very strong. The rolls shewn in Figure 22 are also engine-driven.

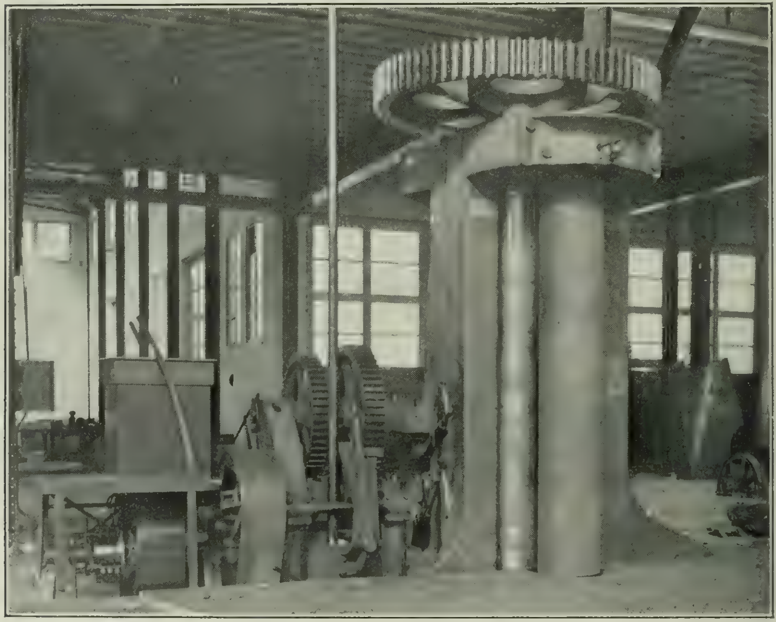


FIG. 24 10-FOOT VERTICAL ROLLS, UNION IRON WORKS, SAN FRANCISCO.

Figure 23 shews a set of rolls driven by belt power, the top roller being worked in the same way. In the larger sizes, like those shewn in the preceding figures, it is necessary to fit girders over the top roller with intermediate bearing rollers, to prevent the bending of the top roller when rolling the plate. Intermediate bearing rollers are also fitted below the two bottom rollers for the same purpose.

The rollers shewn in Figure 25, opposite, are of a lighter type and are designed for working mast plates. When worked in the machine the plate curves round the top roller, and very often the rolled section of a mast plate is a complete circle. The plate, therefore, forms a complete tube round the top roller. In order to withdraw it, a special frame is fitted at one end of the rolls shewn at the right end of Figure 25. The top half of the framing which supports the rollers is arranged to swing clear, leaving the end of the top roller free. This allows the plate to be withdrawn.

Plate-straightening machines for the heavier plates are now generally fitted with five instead of seven rolls as was formerly the practice. They are to take buckling from plates and to give them a fair surface. The plate is put endwise into the rollers, and as in ship work the breadth of the plate seldom exceeds six feet, the width of these machines does not usually exceed about eight feet.

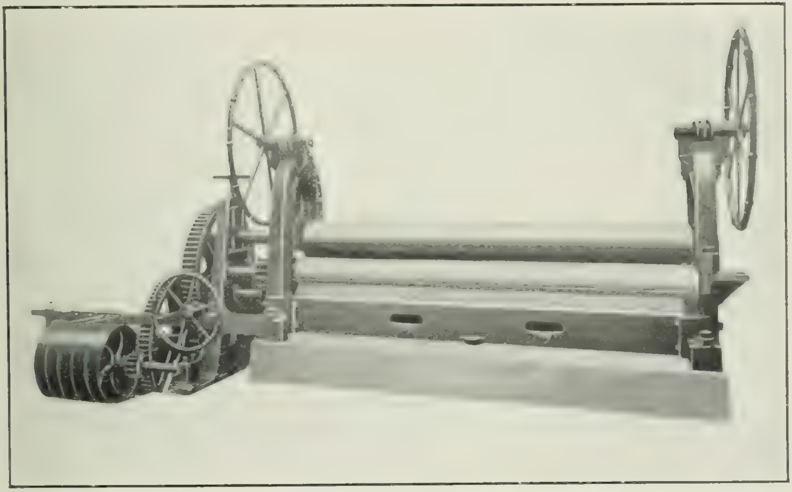


FIG. 25. PLATE-BENDING ROLLS, SUITABLE FOR WORK UP TO [illegible]-INCH THICKNESS AND 11 FEET 6 INCHES WIDTH.

Top half of housing swings clear for removal of tubes from top roller. Craig & Donald.

Figure 26 shews a seven-roll machine. The rollers in this case are 8 feet 3 inches long and suitable for flattening plates up to 8 feet wide by 1¼ inches thick.

A plate-edge planing machine consists essentially of a table on which the plate lies, and a travelling cutting tool. A series of clamping screws secures the plate, and the cutting tool is geared so as to travel the whole length of the table. See Figure 27. Such a machine should be made to take at one cut the longest plate likely to be used in any part of the work, although they are generally arranged so that the top beam, which contains the clamping screws, is overhung, and thus any length of plate may be planed, though the cutting of a longer plate involves two fixing operations. In the later types of this tool the plate is held down by hydraulic rams, instead of by clamping screws, although some of these machines have a combination of both systems. Some machines, such as that shewn, have a swivel head to the cutter so as to plane at any angle. This machine is capable of planing up to 24 feet at a stretch and takes a full cut off a 2-inch plate.

Figure 28 is a patent plate-edge and butt planing machine designed to economise time and save floor space by planing the side and end of a plate simultaneously and at one setting. The end of the plate can be planed at right angles or at an obtuse or acute angle with the side. These machines can be made to plane lengths and widths to suit all requirements, but all machines will admit a plate any length and of any width. These machines are not very commonly used in shipyard, the extra cost and complication of the machine scarcely being repaid by the time saved.

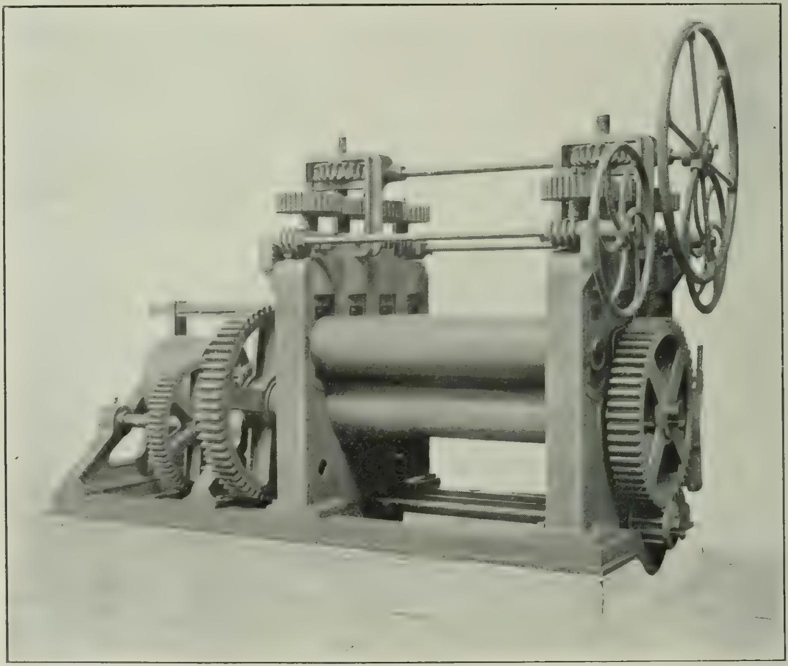


FIG. 26. SEVEN-ROLLER STRAIGHTENING ROLLS.

Capable of flattening plates up to 8-feet wide by 1¼-inches thick. Hugh Smith & Co., Glasgow.

Countersinking machines of the type shewn in Figures 29 and 30 are the most commonly adopted. This machine is designed to work in any position. The gearing carrying the drilling shaft runs along a jib

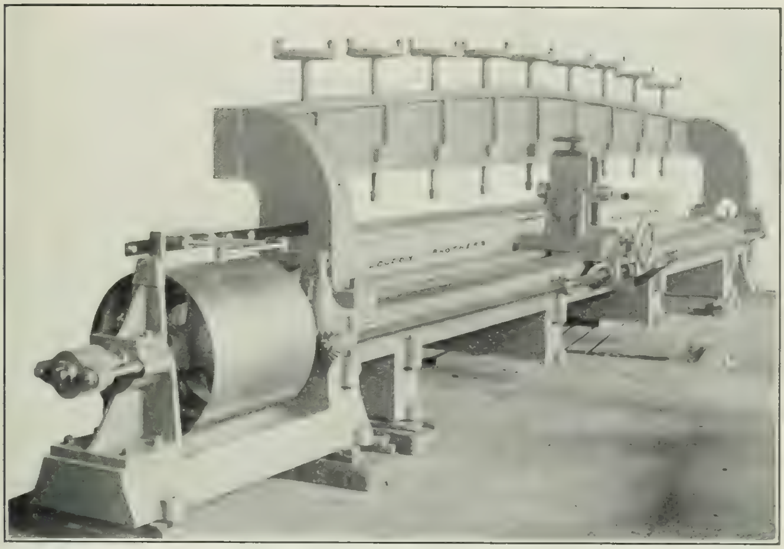


FIG. 27. EDGE-PLANING MACHINE.

which can swing round to any angle. The vertical height of the drill can be altered by raising or lowering the hand lever. These machines should, as a rule, be mounted in groups of two or more, depending upon the size of plate used, in order that as many countersinking tools as practicable may be working upon the plate simultaneously. By this arrangement, the plate when once in position does not require to be moved until it is finished, and the countersinking operation can

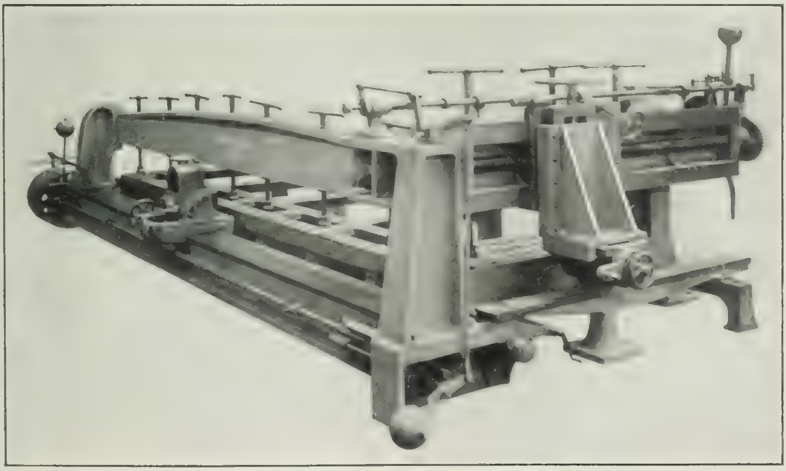


FIG. 28. PLATE-EDGE AND BUTT PLANING MACHINE.
Scriven & Company, Leeds.

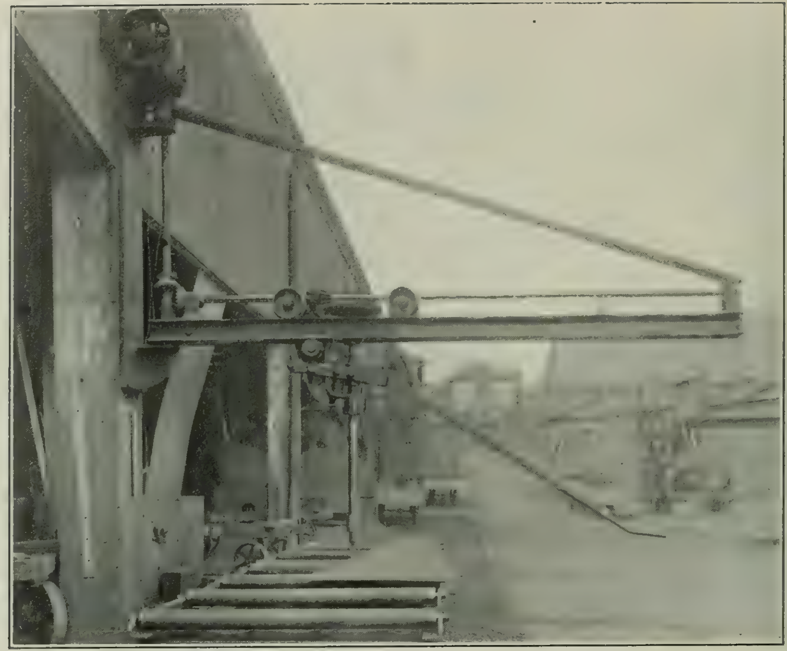


FIG. 29. COUNTERSINKING MACHINE, DOXFORD YARDS, SUNDERLAND.

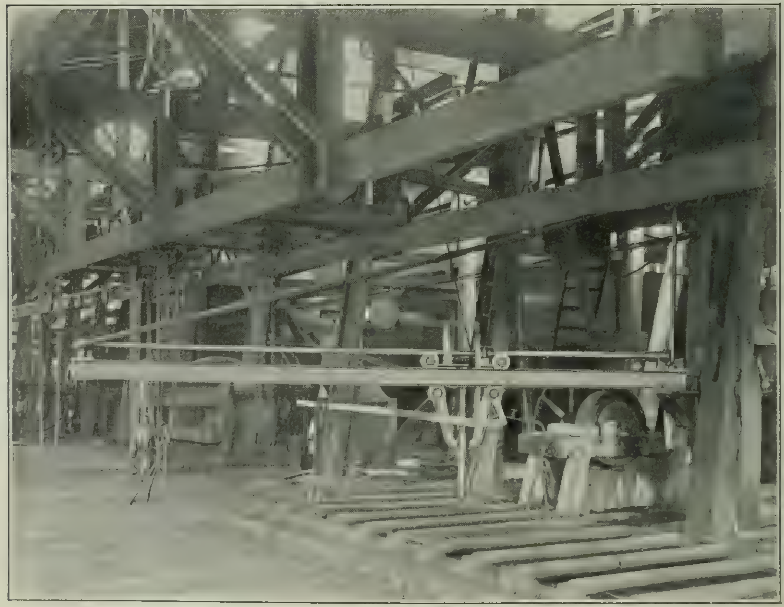


FIG. 30. COUNTERSINKING MACHINE IN THE UNION IRON WORKS, SAN FRANCISCO, U. S. A.

Detrick & Harvey Machine Co., Baltimore.

thereby be done much more rapidly. All plates have to be punched and a very large proportion have to be countersunk, while a much smaller proportion have to be rolled, straightened, and planed. These proportions vary with different types of ships, but are easily determined for any given type of ship. If a yard is consigned to build only one type of ship, the numbers of each type of machine can be determined, and with efficient management a minimum amount of idle time for such machine is obtained; but if the types built in one yard vary, some machines will be fully employed while others will have a lot of idle time. Hence, a yard which builds a variety of ships cannot build any one type as cheaply as the yard which does nothing but that type, other things being equal.

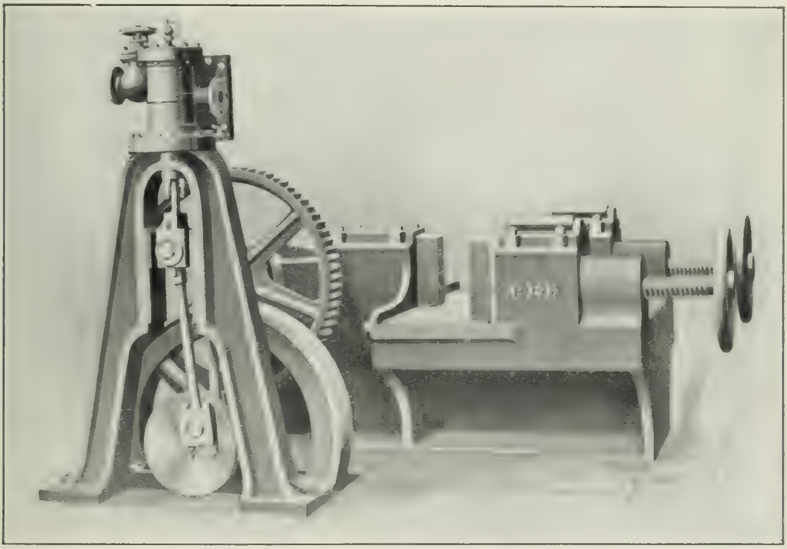


FIG. 31. BEAM OR ANGLE-BENDING MACHINE.
Straightens or bends beams up to 16-inches deep. Craig & Donald.

For bending angles and beams cold a bending machine is employed. The bar or beam is pressed between two bolsters by a ram, as in Figure 31, or is pressed against the ram by the bolsters, as in Figure 34. Figure 31 is a machine capable of bending beams up to 16 inches deep. The ram receives its motion from an eccentric on the driving shaft so that travel of the ram is constant. In order to vary the amount of bend the bolsters can be adjusted by handwheels. In Figure 34 the two bolsters are formed on one slide, which is geared to the driving shaft by an eccentric. The bend is varied in this machine by a hand-wheel on the ram. Figure 33 is a double-ended bend-

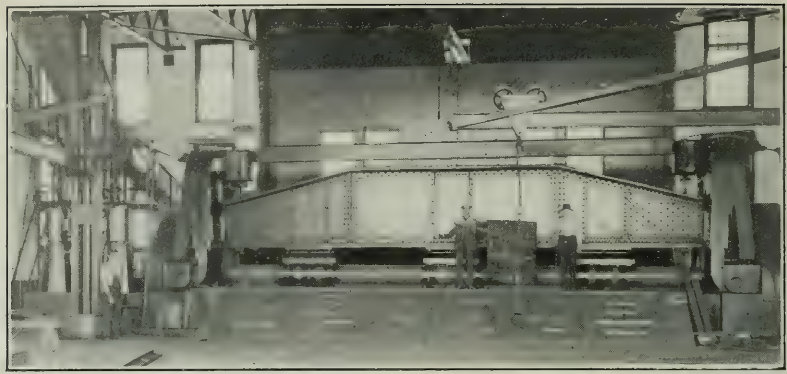


FIG. 32. HORIZONTAL PLATE-BENDING ROLLS. NEWPORT NEWS SHIP BUILDING & DRY-DOCK CO., NEWPORT NEWS. U. S. A.

Handling plates up to 32 feet long and 1⅓ inches thick.

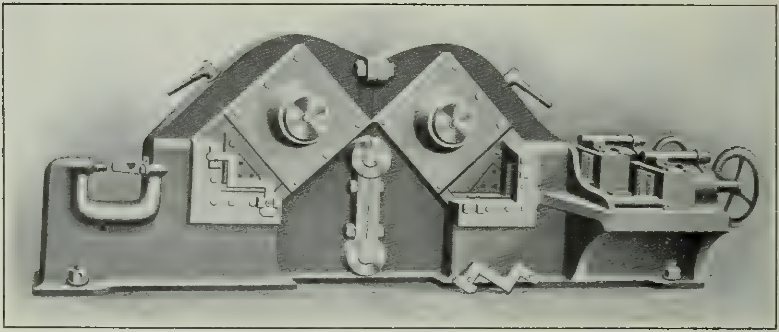


FIG. 33. BEAM OR ANGLE-BENDING, HORIZONTAL PUNCHING, AND DOUBLE ANGLE-CUTTING MACHINE.

Handles 14-inch butterfly or 16-inch ordinary beams. Punches 1½-inch holes in 1¼-inch plate, and cuts (in center, right and left) 12-inch by 10-inch by ⅞-inch angles.

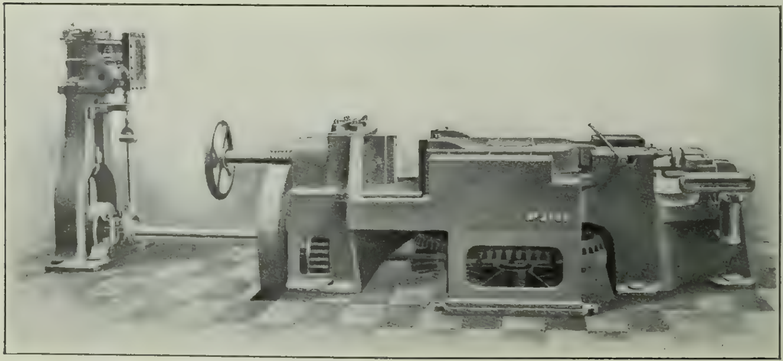


FIG. 34. HORIZONTAL BEAM-BENDING AND PUNCHING MACHINE.

Capable of bending or straightening 14-inch beams and of punching 1¼-inch holes through 1¼-inch plate. The punching die is arranged to punch flanges of H or channel section, from 5-inches deep and upward, or of smaller sections by substituting a smaller die-holder. Craig & Donald.

ing and punching machine for beams up to 16-inch H section, with cutting attachment. Figure 35 is a combined beam or angle bending or straightening, cutting, and horizontal punching machine. It can bend up to 16-inch beams.

One of the tools most recently invented for ship work is the joggling machine. The usual type is shown in Figure 37. In the connections of structures composed of plates, the edges and ends or butts can be connected either by straps or by overlapping. If the latter method is carried out without altering the plate, it often happens that liners of the thickness of the plate have to be fitted to help make a fair surface, but if at the edges or ends the plates are bent to overlap no liners are required. This operation is called joggling, and is effected by the joggling machine, which is essentially a pair of rollers each having a flange like a railway-wheel tyre and overlapping each other. A ship built in this way is partly shewn in Figure 38. This

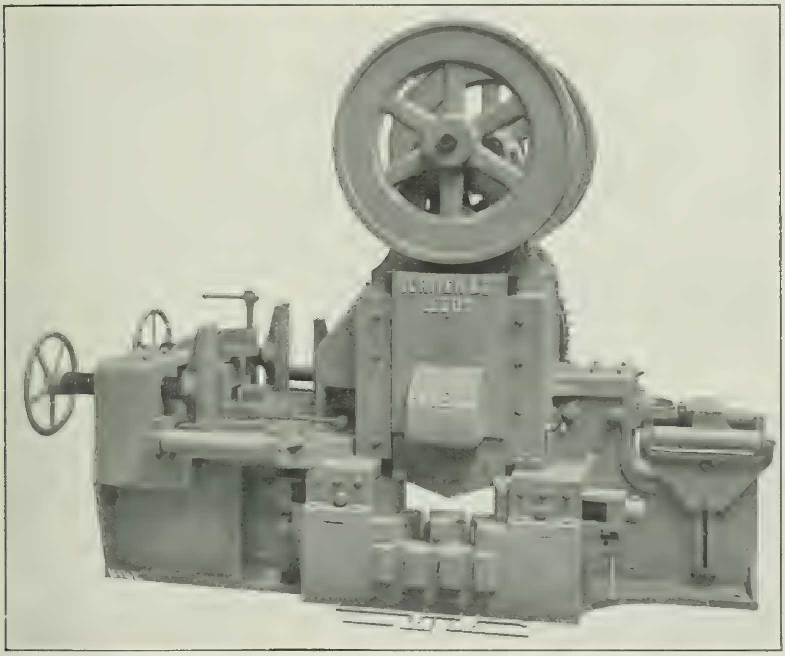


FIG. 35. BEAM-BENDING AND PUNCHING MACHINE, WITH CUTTING ATTACHMENT FOR ANY SECTION.

At one end is combined angle and beam-bending arrangement for bending beams up to 16 inches deep, and horizontal bulb shears for cutting off one side of bulb level with the web to any length for rivetting the knees. The machine will cut part of one leg or angle or Z or notch the same. In the centre is a patent combination for cutting any section of bar any length, up to 15 inches without changing knives. At the other end is a horizontal punch for holes up to 1⅛-inch in any section.

method and the machine for carrying it out were invented and first used by Messrs. Wm. Doxford & Sons, of Sunderland, and the ship in the illustration was built by them.

The saving of time and expense effected by joggling the edges of plates, instead of fitting liners or filling in pieces, is evident at a glance. There is also a considerable saving of weight in large steamers; but for the smaller types, with few decks and thin plates, the loss of displacement due to the outside strakes almost counterbalances any saving

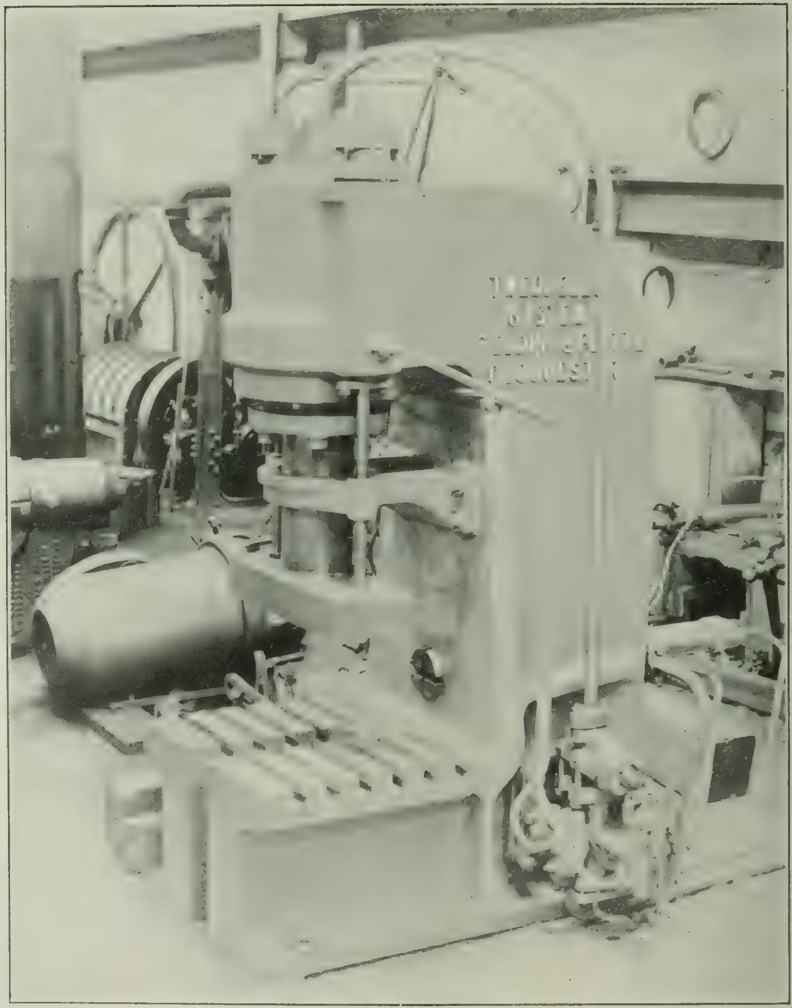


FIG. 36. HYDRAULIC JOGGLING AND BEVELLING MACHINE.

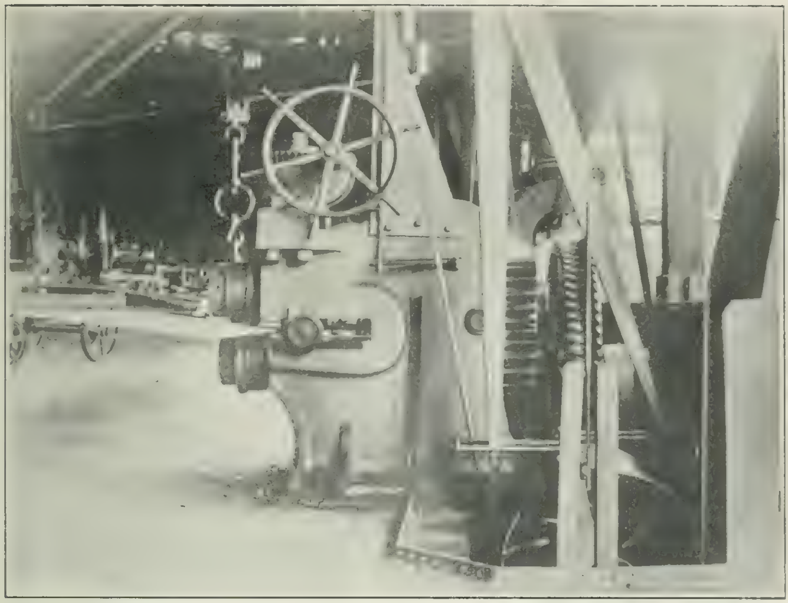


FIG. 37. JOGGLING MACHINE, DOXFORD'S PATENT.

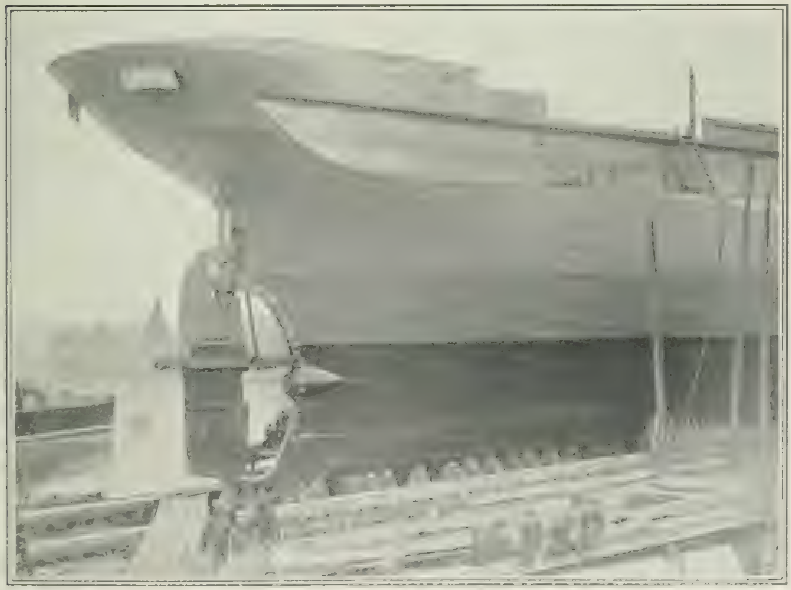


FIG. [illegible]. SHIP WITH JOGGLED SYSTEM OF PLATING.
Built by Doxford, Sunderland

in weight due to the absence of liners. There is an appreciable difference to the wetted surface of the vessel, and this becomes important at high speed. A disadvantage of joggling is the tendency to crack the plates where the joggling is severe.

A machine which has produced very satisfactory work and at the same time saved a great deal of expense is the bevelling machine, Figure 39. This machine is constructed to do either open or shut bevelling, and is generally mounted on rails so as readily to be brought to the mouths of the furnaces by which the bars to be bent are heated. The bars are run through the machine after being taken out of the furnace and are bevelled before being bent, so that the one heat suffices for the whole operation. In the case of hand work, at least two, if not more, heats are required where there is any excessive bevel upon a bar which has to be bent. At the same time, the flange of the bar is seldom straight after the operation, but tends to take a hollow form from the heel outwards. The machine beveller does away with the last objection, as the flanges are bevelled straight from the heel outwards. An indicator on the machine gives the required bevel at any point.

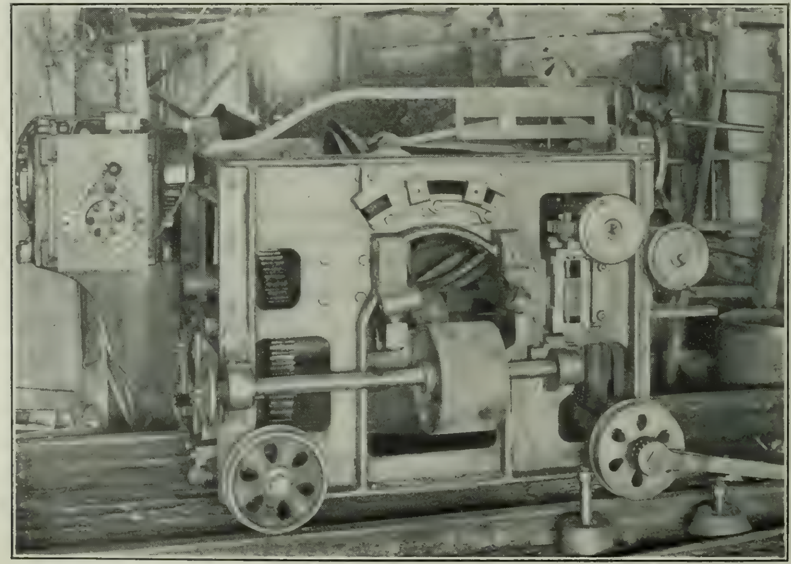


FIG. 39. ANGLE-IRON BEVELLING MACHINE, UNION IRON WORKS, SAN FRANCISCO, U. S. A.

Davis & Primrose, Leith.

The use of hydraulic power in shipyards in the United Kingdom is not accompanied with serious difficulties from climatic considera-

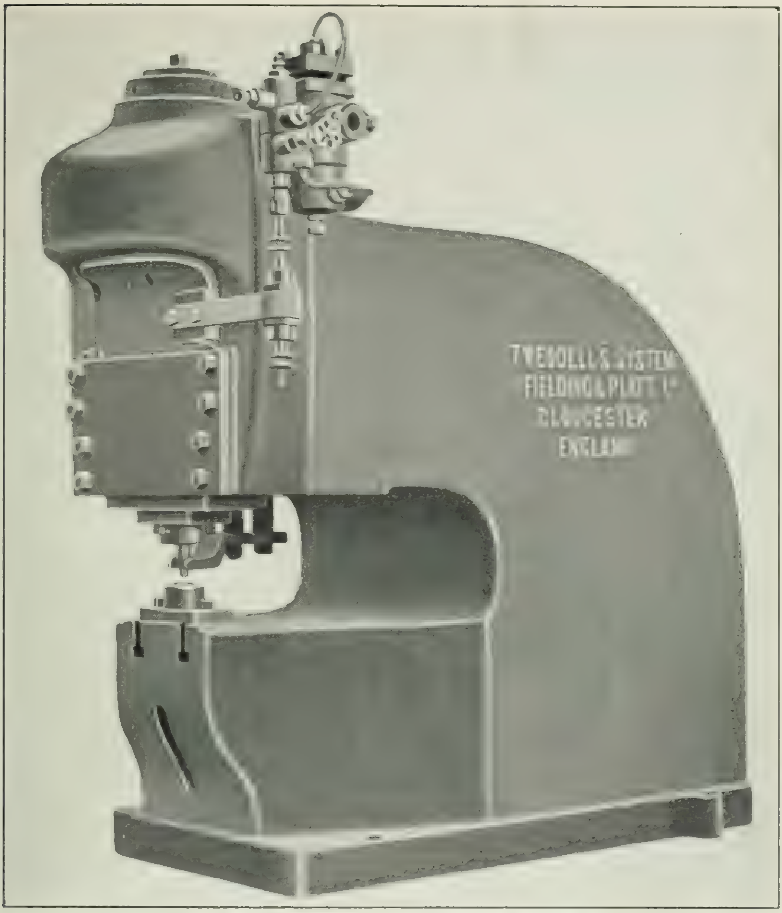


FIG. 40. HYDRAULIC PUNCHING MACHINE.

tions, the duration and severity of frost being rarely sufficient to cause much trouble. For manipulating the heavier class of flanging, punching, and rivetting machine, hydraulic power certainly possesses great advantages over some of the other forms. It is not so delicate and does not require the same attention as electric power, and is on the whole cheaper and can be used in places where direct steam power is not suitable. Few British establishments have as yet adopted compressed-air plants. For rough handling, inseparable from most shipyard work, hydraulic or compressed-air power possesses some advantages over electric power; but the latter is much more flexible in its application, as wires are much more easily led and taken care of than pipes. The operations for which hydraulic power is most commonly used are for flanging plates, punching man-holes or large lightening holes, and hoisting and rivetting, although tools for nearly all the other operations, such as punching, shearing, etc., may be driven by this method.

Figure 40 is a hydraulic punching machine. Figure 42 is also a punching machine, but can be used as a rivetter as well.

Flanging machines for the heavier plates should be capable of taking in the longest plates used. It is possible to flange thin plates in small lengths at a time without injury to the plates, so that a machine with sufficient scope for flanging short lengths of plates, such as brackets, intercostals, etc., can also be used for lighter work such as casing plates. The type of machine in general use for the heavier work, such as keel plates, bulkhead plates, etc., is one of the form shewn in Figure 41. Here the plate is inserted below a beam forming the back of the machine, and is fixed by a lower beam which is moved up an inclined plane until it jams the part of plate inserted. The roller shewn in front is then moved up by hydraulic power and gives the plate the required flange. Figure 43 is a hydraulic keel-plate bending machine capable of bending both sides of a keel plate at the same time. Two hydraulic cylinders at each end give the power necessary

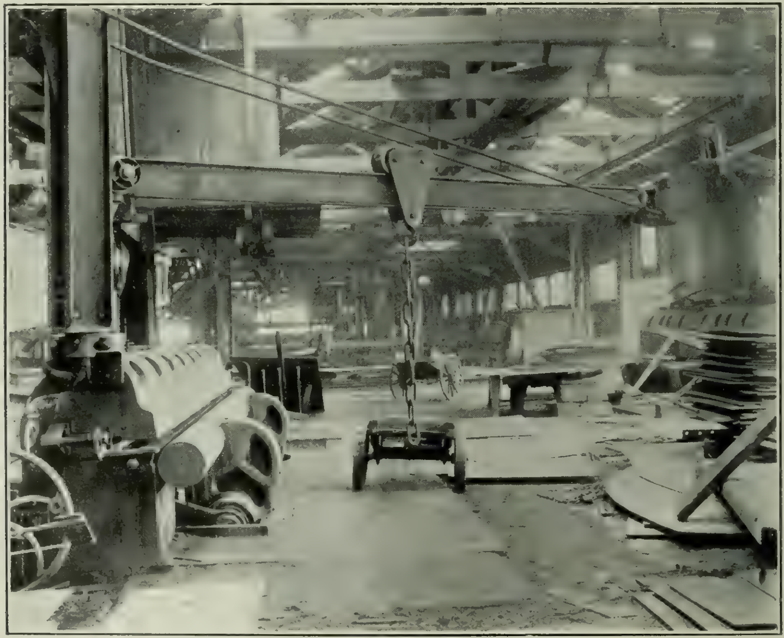


FIG. 41. HYDRAULIC FLANGING MACHINES.

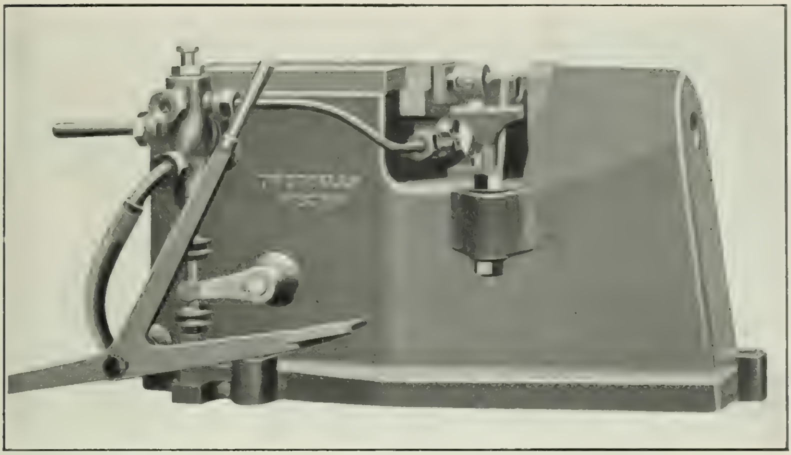


FIG. 42. HYDRAULIC PUNCHING AND RIVETTING MACHINE.

for bending the plate. The sides may, however, be used independently of each other if required. Figure 44 is a hydraulic flanging machine of the same type as Figure 42, only the roller when flanging moves downward, instead of upwards as in Figure 42. Hydraulic cranes are fitted at each end of this machine for handling the plates.

Figure 47 shows a powerful hydraulic oval or man-hole punching machine for punching at one stroke round or square holes up to 21 inches by 18 inches in ¾-inch thick plates. The machine has a bed-plate upon which the dies are fixed, and a cross-head in which is placed

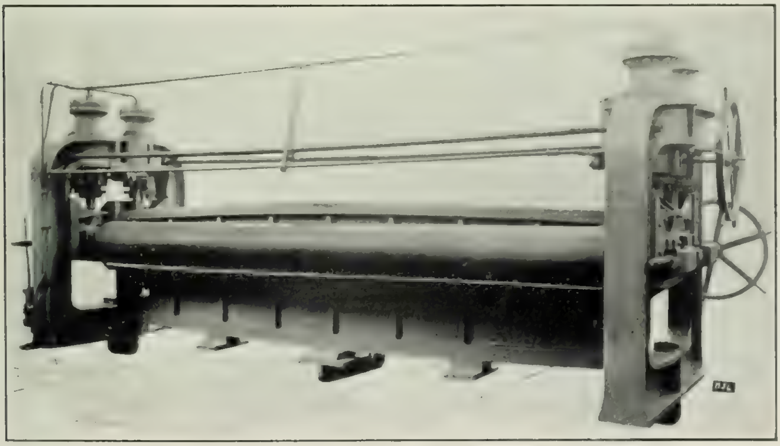


FIG 43. HYDRAULIC KEEL PLATE-BENDING MACHINE.

Bends both sides at once uniformly to a channel section, either parallel or tapered to any degree of twist. Will also flange stringer plates, bulkhead plates, floor plates, knees, etc. Scriven & Co., Leeds.

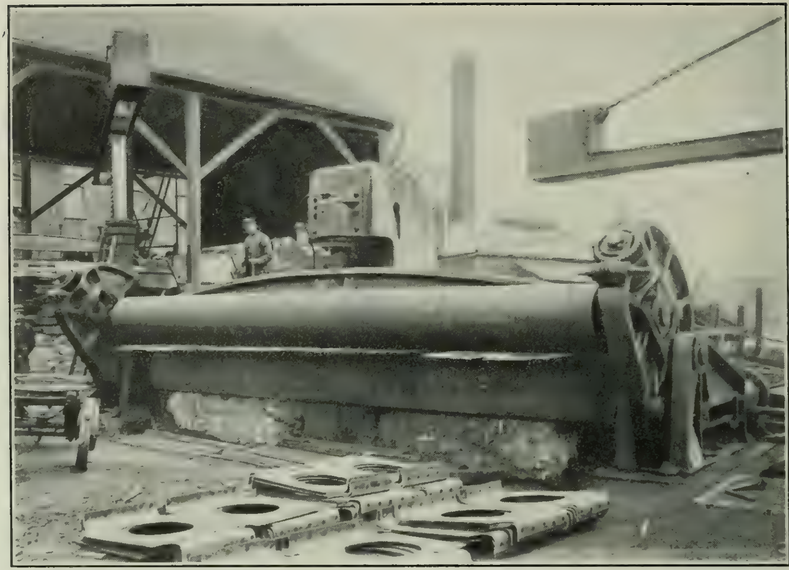


FIG. 44. HYDRAULIC PLATE-FLANGING MACHINE, DOXFORD, SUNDERLAND.

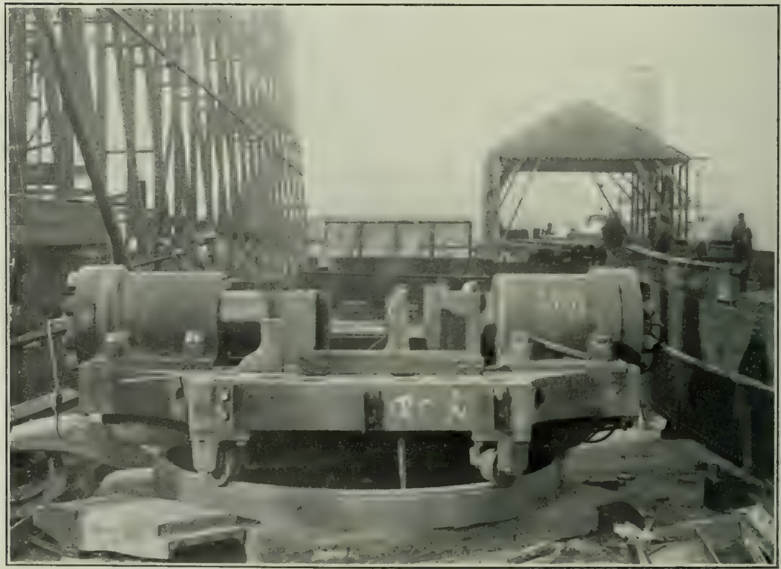


FIG. 45. HYDRAULIC BENDING MACHINE, YARDS OF UNION IRON WORKS, SAN FRANCISCO, U. S. A.

the hydraulic cylinder and ram for carrying the punches. Bed-plate and cross-head are held apart by four strong steel pillars to allow plates 6 feet wide to pass through. Figure 46 is a hydraulic man-hole punching machine which can also be used for joggling or bevelling.

Figure 48 is a patent hydraulic shearing and bending machine. This machine is provided with two angle-bar cutters in the centre of the machine for cutting either right or left hand. At the end of the machine there is an angle-bar and beam-bending and straightening arrangement to admit beams up to 12 inches deep. The power is obtained by a hydraulic cylinder which is arranged to work at two powers with the same water pressure; the larger power to be used for larger sections of bar, etc., and the smaller power for the lighter sections, thereby effecting a considerable economy in the consumption of water.

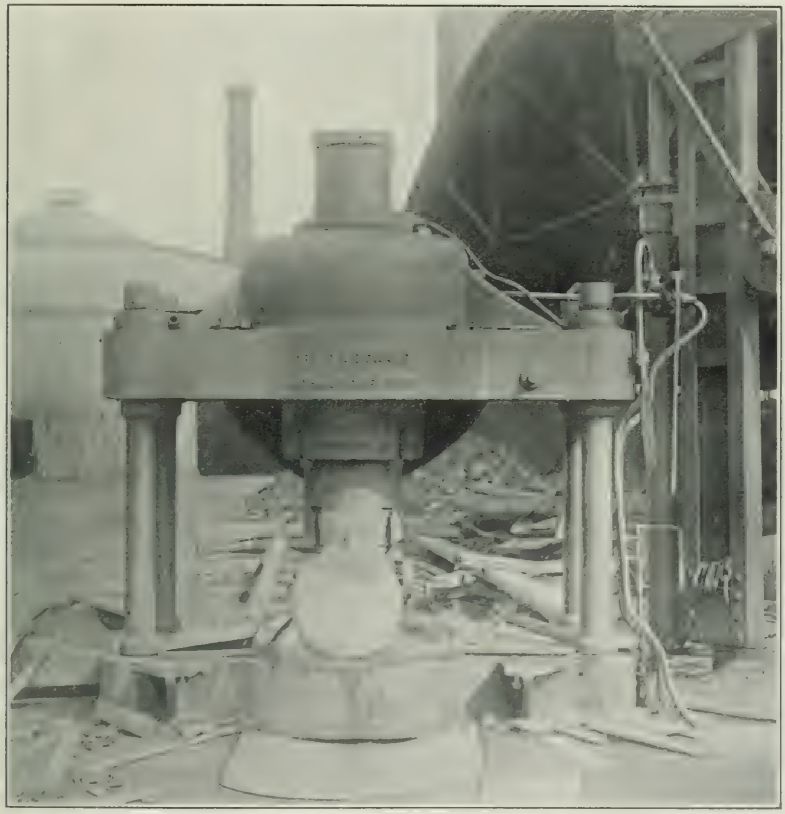


FIG. 46. HYDRAULIC PRESS FOR FLANGING, JOGGLING, OR PUNCHING MANHOLES.
Built by Craig & Donald for Denny Bros.

The use of hydraulic rivetting machines is now almost universal in Great Britain. Certain parts of a ship's structure, such as the frames and floors, are usually assembled at the head of the slipway upon which the vessel is to be built, and at this point are placed two or more machines slung from the jib of a fixed crane by means of small lifts. A light staging is erected on which the parts rest while being rivetted together. This operation usually takes place while the keel is being laid and the staging being erected. In the construction of a steamer

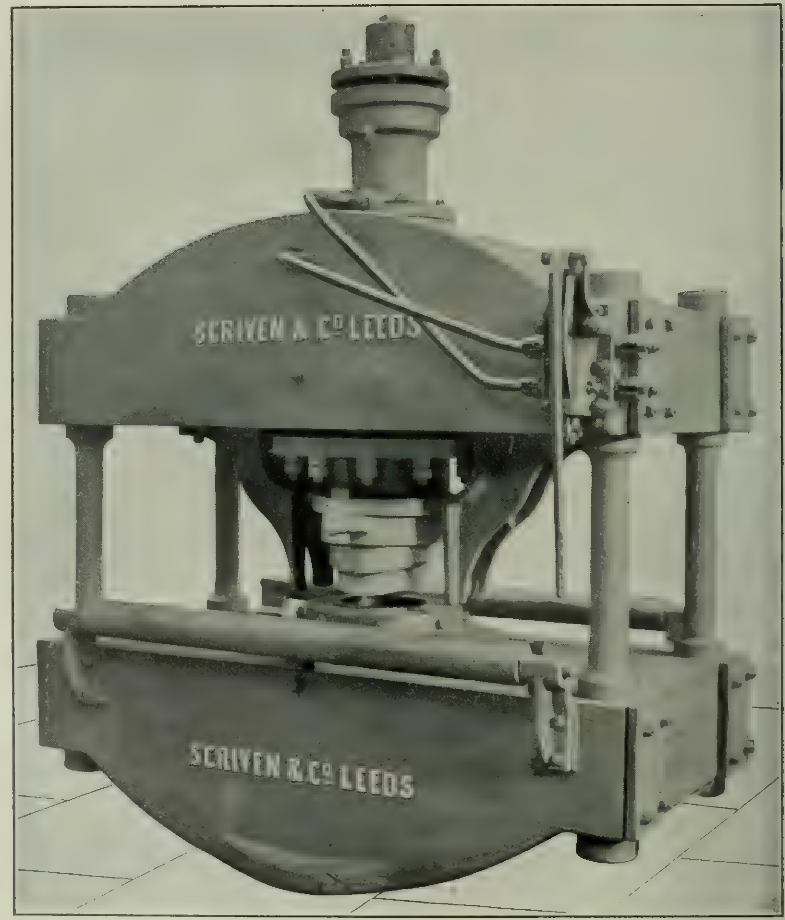


FIG. 47. HYDRAULIC OVAL OR MANHOLE PUNCHING MACHINE.

Punches at one stroke large round or square holes up to 21 inches by 18 inches in ¾-inch plate. Plates 6 feet wide can pass between the four strong steel pillars which hold apart the bed-plate, on which the dies are fixed, and the crosshead carrying the hydraulic ram and punches.

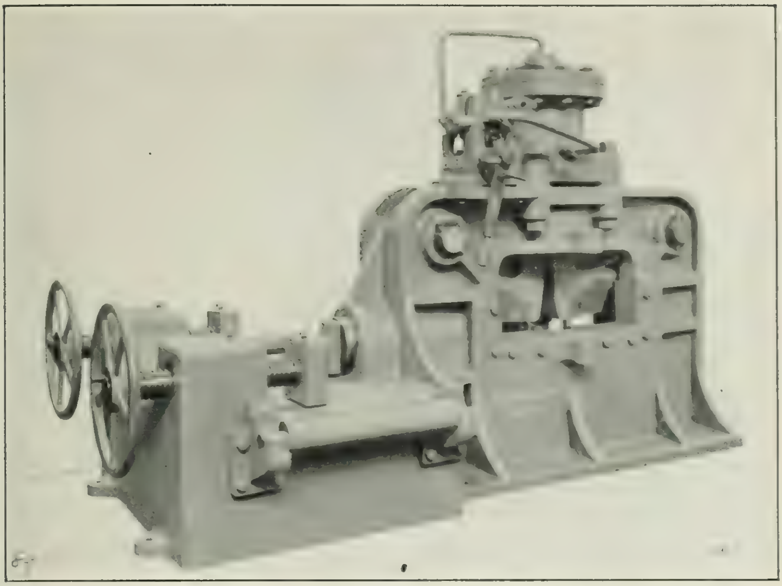


FIG. 48. HYDRAULIC SHEARING AND BENDING MACHINE.

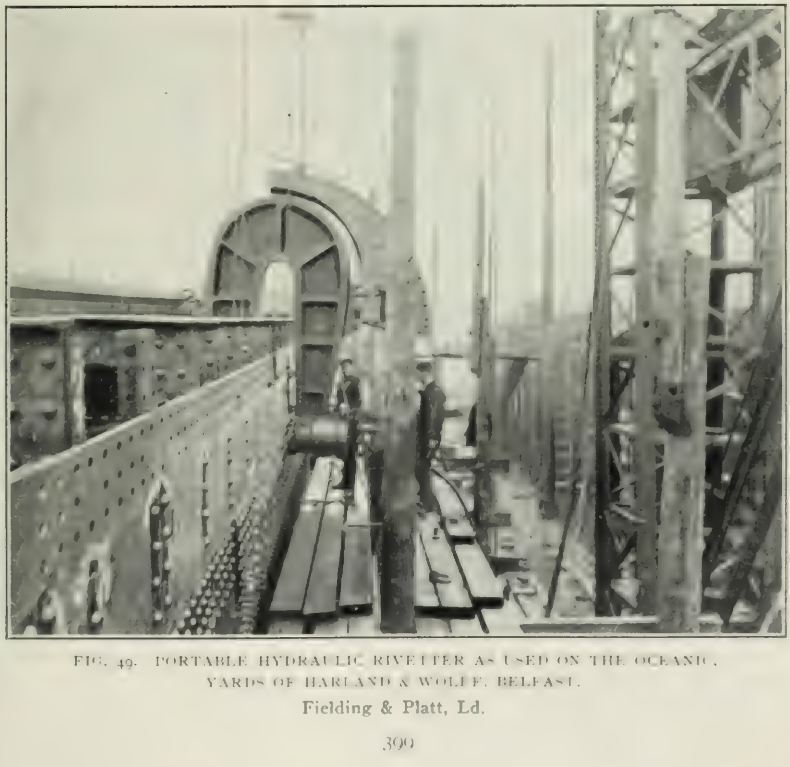


FIG. 49. PORTABLE HYDRAULIC RIVETTER AS USED ON THE OCEANIC, YARDS OF HARLAND & WOLFF, BELFAST.

Fielding & Platt, Ld.

with a double bottom (see midship section, Figure 50) the floors and connecting angles are rivetted first. These are then lifted onto their position marked off on the keel, shored up, and faired, while the frames and connecting brackets are being rivetted. After the margin plate is fitted the frames are lifted into position and faired. Figure 4 gave a view of the framing at this stage of construction. The rivetters used in the work over the light staging are of a light pattern (see Figures 49, 51 and 52). No great gap is required, as in the framing work at this stage there is no corner work to do.

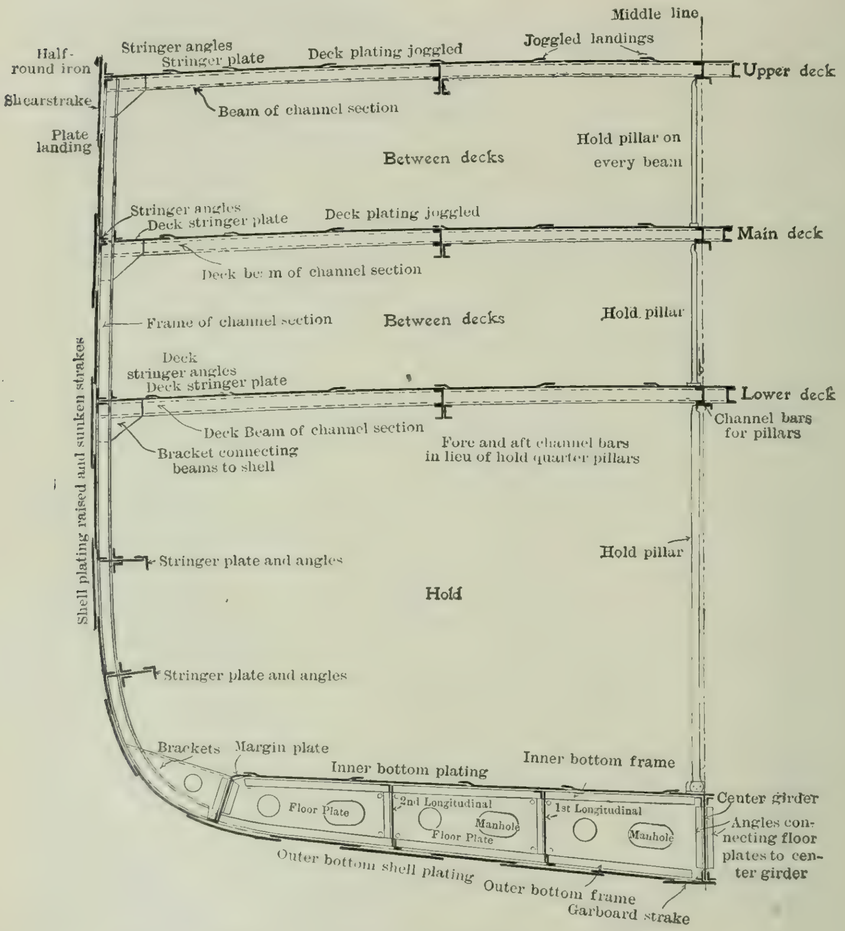


FIG. 50. MIDSHIP SECTION OF A STEAMER 500 FEET LONG

ON THE DOUBLE BOTTOM PRINCIPLE

The rivetter shewn in Figure 51 is merely a strong frame forming a gap at the end of which are the rivetting dies. One of the dies, the closing die, forms the ram of the hydraulic cylinder. This rivetter is provided with a clip, by sliding which along the frame the machine can be made to work with the cylinder underneath, instead of above, as shewn, or in any intermediate position.

Fig. 54 is a rivetter of the same type but provided with a bow hanger. The machine in this case rotates on the gudgeon through a complete circle, and in order to suspend it with the arms horizontal it is necessary only to connect the swivel onto the gudgeon instead of to the end of the bow. In moderate sized vessels the whole of the frame, reverse frame, floor, and intercostal angles and beams may be rivetted together before erection. In a few cases the beams may not come exactly fair with the rest, but with fair laying off and templating there should be no difficulty in obtaining a fair deck. Even if a few beams have to be cut and re-rivetted after they are in place, there is a great saving in time and expense by adopting the method stated above.

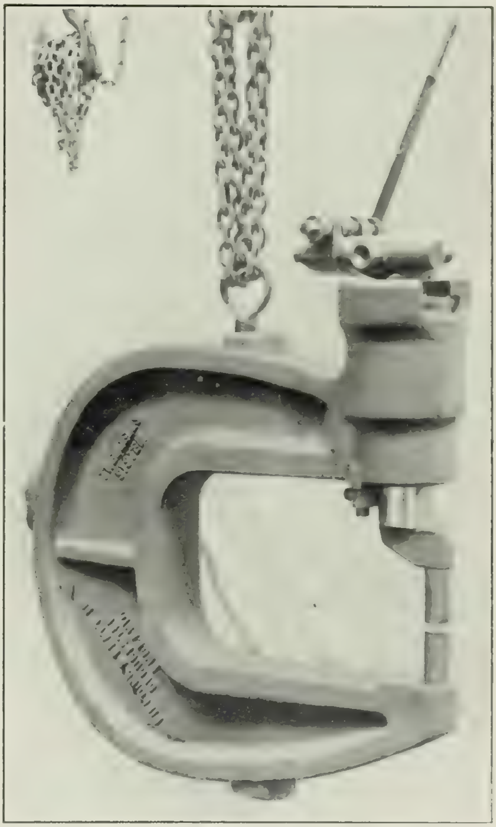


FIG. 51. PORTABLE DIRECT-ACTING HYDRAULIC RIVETTER FOR SHIP'S FRAMES. USUALLY SUSPENDED BY A CLIP.

Tweddell System. Fielding & Platt, Gloucester

With suitable arrangements for carrying them, hydraulic rivetting machines may be used for almost any part of a vessel, except where flush-rivetting is required. After the bottom framing has been erected, small travelling cranes for carrying these machines may readily be mounted on travelling rails. In this way all intercostals, keelsons, side stringers, may be hydraulic rivetted. When it is re-

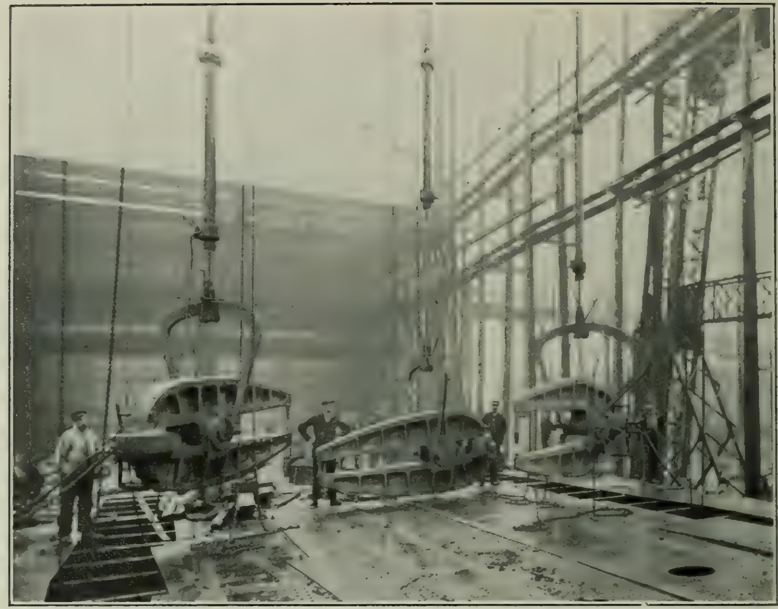


FIG. 52. HYDRAULIC RIVETTING MACHINES AT WORK ON INNER BOTTOM, S. S. OCEANIC, YARDS OF HARLAND & WOLFF, BELFAST

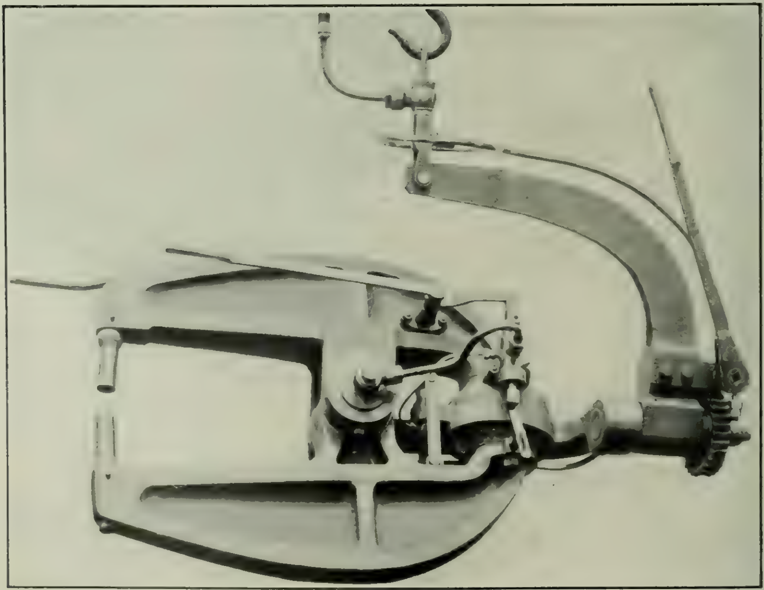


FIG. 53. PORTABLE HYDRAULIC RIVETTER HINGED TYPE FOR GENERAL WORK

Fielding & Platt, Ld.

membered that the saving effected by the use of hydraulic rivetting may amount to from 30 to 40 per cent., to say nothing of the superior workmanship, the advantage of so arranging the work that machine work may be used whenever possible is evident. In the case of double-bottomed vessels nearly the whole of this plating may be machine rivetted. The machines for this class of work require to have a much larger gap than those just considered, except perhaps those used for intercostal work in the inner bottom, and this means a heavier and more cumbersome machine to handle, and involves the use of correspondingly heavier cranes or some arrangement such as a travelling gantry.

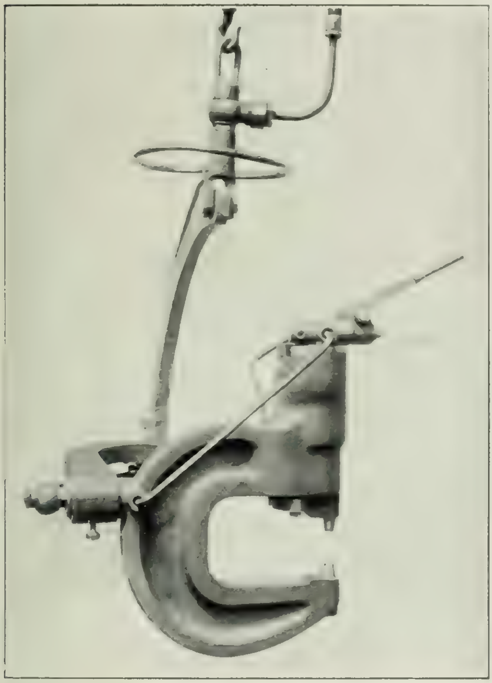
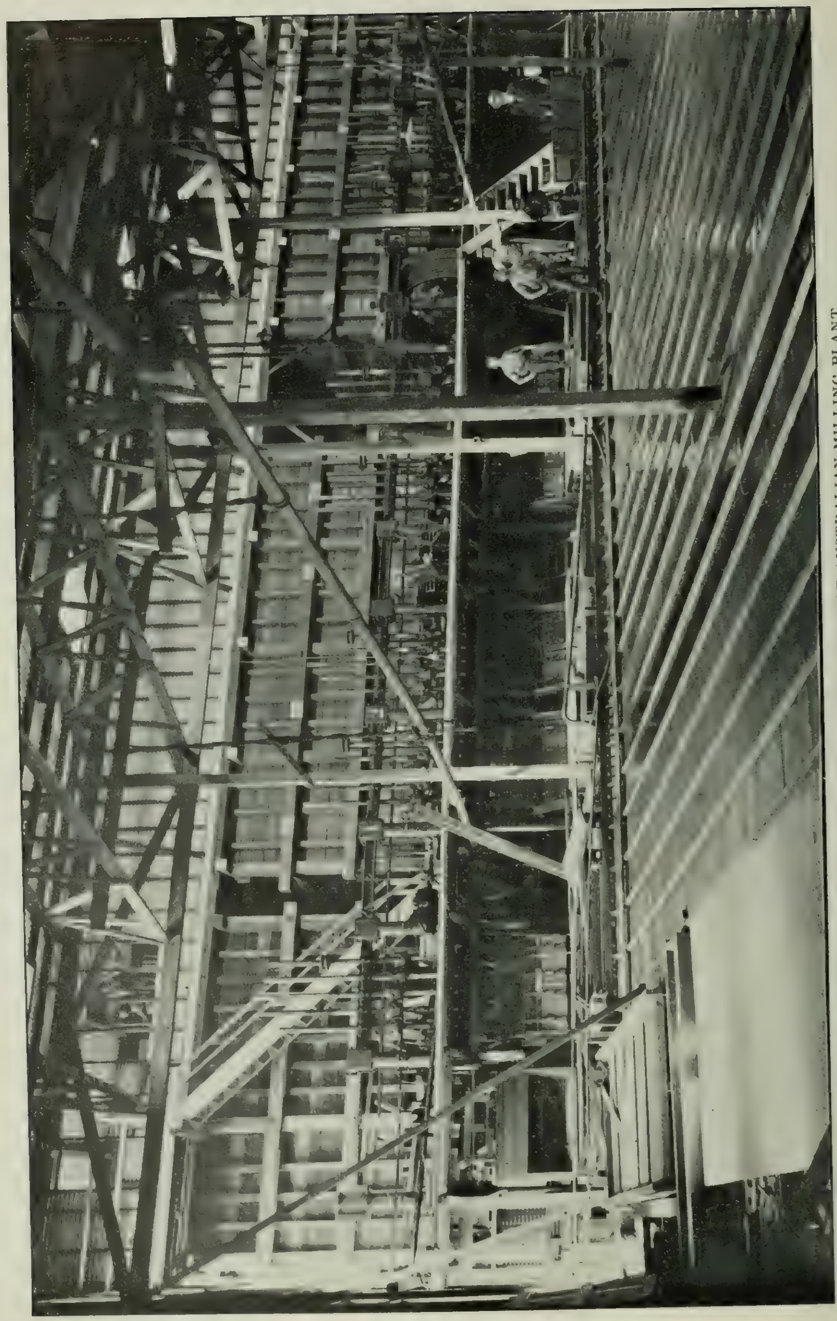


FIG. 54. SMALL LIGHT DIRECT-ACTING HYDRAULIC RIVETTER.

With special compound hanger for being slung in any direction. Fielding & Platt, Ld.

Figure 53 shows a portable hydraulic rivetter which is used for this part of the construction. The rivetting dies are clear of the hydraulic cylinder, so that they can get into corner work about the intercostals in the bottom. The levers carrying the dies oscillate on a strong steel centre pin or gudgeon. The hydraulic cylinder and ram are placed at the other end of these levers, and by making the centre line of this cylinder follow the radial path of the arms of which the cylinder forms the outer end, connecting rods between the two levers are avoided. The thickness of the sheerstrake plates and doublings in the large class of vessels has made hydraulic rivetting most imperative owing to the correspondingly large size of rivets.

The discussion of pneumatic tools is necessarily left for the succeeding article, which will conclude with a review of the upkeep of tools, and the general arrangement of the ship-building plant.



THE IVANHOE MILL. A CHARACTERISTIC WEST AUSTRALIAN MILLING PLANT.

GOLD MINING AND MILLING IN WESTERN AUSTRALIA

By A. G. Charleton

V.—MILLING AND CYANIDING PRACTICE AT KALGOORLIE.

Mr. Charleton in this paper concludes the comprehensive review of the Westralian mining field begun in this Magazine in February last. His preceding papers have dealt with topography, geology and general conditions, the dry-blowing process, the water problems of the field, and mining methods and costs.—The Editors.

THE ore-treatment works of West Australia are of three principal classes—mills for crushing the brown-stone, cyanide works for the treatment of oxidised mill-tailings, and sulphide works.

No particular difficulty has been experienced in treating the brown-stone, although, owing to small and inefficient installations, scarcity of water, and high prices, it entailed considerable cost in the early days of the field; and no doubt in some cases there were heavy losses of gold in the tailings. Most of this gold, however, has since been recovered in the cyanide works erected for the purpose. In recent years, with larger and better-equipped mills, improved management, and cheaper means of communication, the cost of milling by wet crushing and amalgamation has been brought down to more reasonable figures. The principal metallurgical difficulty arose from the sliminess of the ore, caused by the presence of silicates of magnesium and alumina and hydrated oxides of iron which, according to H. P. Woodward's estimates, amount to over 40 per cent. of the entire lode stuff. He also expresses the opinion that the tailings of the more modern mills carried as a rule not more than 8 dwts. of gold per ton, which is probably not much under the mark, and considering the nature of the ore, its richness, the fine state of division of the gold, and the quality of the water used, is not a bad showing. Speaking of an earlier date, however, Baron Sloet van Oldruitenborgh remarks that several existing heaps of tailings, carried ¾ of an ounce to 2 ounces of gold per ton.

Mr. G. J. Bancroft* gives a screen analysis of what he regards as a typical milling-ore in this camp:—

0.8	parts per	100 remain on a	25	mesh screen.
0.98	”	”	30	”
9.34	”	”	40	”
16.63	”	”	60	”
17.43	”	”	80	”
5.50	”	”	100	”
49.32	”	passed through	100	”

Following which he gives a chemical analysis of a similar ore:—

		Per cent.
	Silica	48.43
	Iron	10.4
	Alumina	1.98
	Lime	9.86
	Magnesia	2.03
	Sulphur	3.66
	Copper	6.35
Calculated		
	Carbonic Acid	7.75
	Oxygen in Oxide of Iron	3.05
	Alkalies, etc., undetermined	6.49
		100.00

From this he draws the deductions:—1.—That the 50 per cent. of slimes present will cause trouble by packing. 2.—That the 10 per cent. of lime present (irrespective of magnesia) places chlorination out of the question.

The grade of the ore milled, as well as the fineness to which it is crushed, no doubt to some extent influences the grade of the tailings; and the increasing muddiness of the water, when pumped back over and over again without being properly settled, as it used sometimes to be when mining first started, contributed to the losses referred to, quite apart from any injurious action the salts in the water might have. Bergrath Schmeisser appears to think that less than 55 to 60 per cent. of the gold was saved in the older mills, whilst Baron Oldruitenborgh asserts that they hardly ever extracted more than 65 per cent., and then only when dealing with the most perfectly oxidised ores treated, the average being probably about 50 per cent. These losses may be ascribed to the amorphous unamalgamable (rusty) state of some of the ochreous ore, besides float gold which escaped the plates, in addition to a certain proportion of gold locked up in sulphides, which the ores carried even in the upper levels. To obviate losses of this sort, some of the mining companies erected Berdan or other pans, by which they succeeded in saving an additional 10 to 20 per cent. of the gold originally contained in the ore. Blankets were put in, in addition, to save the coarsest sulphides and tellurides that escaped, as well as some of the amorphous gold. By these means they obtained a certain quantity of concentrates, worth from 2 to 40 ounces of gold per ton, which were shipped to smelters.

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* Kalgoorlie, West Australia, and its Surroundings." Trans. Am. Inst. of Mining Engineers. Feb., 1898.

The largest batteries at this period contained thirty stamps, more often only five to ten heads, which crushed from 1½ to 2¼ tons per stamp-head per day—a small showing, compared with 3½ to 6 tons per stamp-head crushed in recent years in South Africa, in mills often containing eighty to two hundred and forty stamps each; there are various reasons, however, why it will not pay as a rule to run through the soft brown-stone of Western Australia so rapidly; partly because its exceptionally clayey consistency either tends to clog the mortar and plates, or involves a heavy consumption of that most expensive commodity, water; partly because its much higher grade would entail liability to a large escape of fine free gold with the tailings. This affords an excellent illustration of the fact that all ores cannot be treated alike, even for the extraction of the free gold.

The following table, given by H. C. Hoover,* shows the gradual growth of the industry in Western Australia, as indicated by the size and number of the mills in each district, the tons of ore crushed, and the yield in 1897; but, as will be seen later, as the tonnage crushed has increased the grade of the ore milled has naturally fallen.

District.	No. of Stamps.	No. of Mills.	Av. No. of Stamps per Mill.	Tons of Ore Crushed.	Total Yield, Ozs.	Av. Bullion. per Ton. Dwts.
Coolgardie	329	24	13.3	9,196¾	8,684¼	18⅞
E. Coolgardie (Kalgoorlie)	265	15	17.6	18,402½	31.735	34½
North East Coolgardie....	182	16	11.4	4,123¼	3,729¾	18
Broad Arrow.............	206	15	13.7	2,632	1,791¾	13½
N. Coolgardie............	318	24	13.2	2,665	5,284	39⅝
Mt. Magnet..............	128	13	9.8	2,752¾	5,145¾	37½
Yilgarn	125	7	17.8	2,855¾	1,148¾	8
Dundas	186	16	11.6	2,631	2,707½	21¼
Murchison	445	33	13.4	6,788½	7,802½	22⅞
E. Murchison.............	48	4	12.0	1,949½	2,907¼	29¾
Yalgoo....................	40	5	8.0	516	644½	24⅞
Pilbarra	15	2	7.5	407½	603¾	29¾
Peak Hill.................	20	2	10.0	447	1,734	77⅔
Northam	80	1	80.0			
Totals	2,387	177	13.4	55,367½		26¾

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* *Mineral Industry*, Vol. VI., The Working Cost of West Australian Mines.

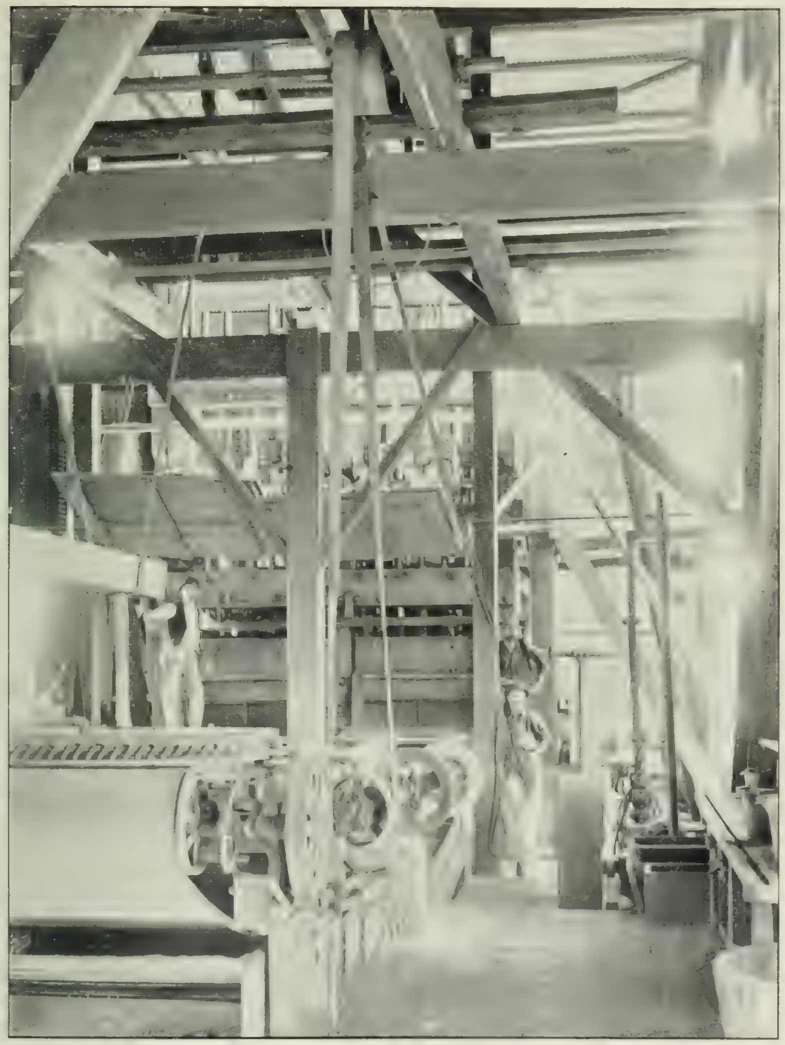
Two somewhat different types of crushing and amalgamating machinery have been employed in milling, viz.:—ordinary stamp batteries and Huntington mills.

Huntington mills have done excellent work, both at the North Boulder mine, where they were first introduced, and at the Oroya, which latter plant, consisting of three mills, crushed 26,954 tons in 1899 for a yield of 10,722 ounces of bullion. Between September 1, 1896, when crushing commenced, and November 16, 1896, the North Boulder in its old original mill treated 533 tons for a yield of 1,160 ounces, giving an extraction of 2¼ ounces per ton with a loss, as shown by assay, of 10 to 14 dwts. in the tailings, representing a yield of about 78 per cent.

The results of this trial were deemed so satisfactory in point of extraction and cost that another 5-foot mill was bought, and this, together with the old one, is still running, with the stamps which were afterwards added to the plant.

The comparative slowness of its discharge, and the rubbing action to which the free gold and gold in combination with other minerals are subjected in a Huntington mill, I am inclined to think, give it an advantage over stamps in the matter of extraction, when treating an ore like the Kalgoorlie brown-stone. Mills of this type are excellent amalgamators, are comparatively cheap and simple to erect, and take less time to put up than stamps, enabling a mine when in the stage of a prospect to get to work quickly, to prove its value on a milling basis, and to earn profits when perhaps it could not afford to stand the cost and delay entailed by the erection of a large battery; these mills require little power, and are cheap to run. They are not, however, so well suited as stamps for large outputs, when dealing with hard-ores. The capacity of a 5-foot mill, I reckon, is liable to fall to about 13 or 14 tons per 24 hours, if fine screens are used, when any considerable quantity of unoxidised ore is mixed with the stone crushed. A mill will, however, put through 17 or 18 tons of softer mill-rock, and would probably crush more, with careful feeding and coarser screens, if the stone is first broken fine in the rock-breaker.

At the North Boulder, the mills are provided with automatic feeders (the ore being previously broken in a stone-breaker and passed through a grizzly). The ore, after crushing in the Huntington, passes over a length of 9 to 10 feet of silver-plated-copper table-surface, 5 feet in width, one table being broken by a drop of two inches and a shallow well, whilst the other has a double-drop well in the middle and a drop of 6 inches at the foot of the second plate. The



NORTH BOULDER STAMP BATTERY.

plates have an inclination of about 1 1/3 inches per foot run, and additional clear water is supplied by a perforated pipe at the head. Below both mills, there is a set of blanket-tables, 11 feet in length and 5 feet in width, each divided into four strakes, pitched on a grade of about 1.4 inches per foot. Their purpose is to collect any free gold or amalgam that might escape the mills. The screens are No. 40 diagonal slot, without any burr, and the mills are run at 65 to 70 revo lutions per minute, requiring some 700 gallons of water per hour, and are charged with about 70 pounds of mercury.

The cheapness with which mills of this class can be operated is shown by the results achieved at the Spanish Mine, Nevada Co., Cal.,* and the costs at the Oroya are shown in the table below:

			Twelve Months to Sept. 30th, 1899.	Six Months to March 31st, 1900.
Tons crushed			25,234	13,601
			s. d.	s. d.
Water,	"	"	2.0	1.8¾
Wood,	"	"	1.5½	1.6¾
Supplies, etc.,	"	"	.10	1.5½
			7s.11½d.	8s.9d.

The costs on a large scale at North Boulder cannot be given exactly as, being a composite mill, the cost of labour, water, fuel, etc., used by each class of machinery, cannot be kept separate.

The following particulars of typical mills will serve to illustrate the important features of the milling practice in the battery plants.

The Lake View 50-stamp battery, which I saw in 1898, struck me as being a well-erected and arranged plant, besides being the largest on the field. The ore is crushed in a Gates crusher at the shaft, and elevated by a travelling wire rope-way with buckets to the top of the building, where it is trammed and dumped into a line of bins at the back of the stamps. The stamps weigh 900 pounds, have a fall of 6 inches, and are run at 90 drops and fitted with gib-tappets. They are driven by a compound engine with cotton ropes running in grooved pulleys. The ore feeders are of the Challenge pattern, and it is stated that 4 tons per stamp head, or 200 tons per diem, were being crushed in the autumn of 1898. The gold is caught on amalgamated copper plates and canvas strakes, whilst the tailings, which are saved, are treated by cyanide as described in its proper place. It may be added, however, that this combined treatment is stated to save 90 per cent. of the gold contained in the brown-stone, whilst during the year ending August 31st, 1898, 64,687.7 ounces were obtained from the battery, by the amalgamation treatment of 57,725 tons of ore at a cost of 10s. 1.2d. per ton, and 56,506.47 ounces in 1899, by the treatment of 81,866 tons, at a cost of 6s. 10.463d. per ton.

The Lake View South 20-stamp battery is of a different type from that just described. It is built on a graded mill site, on the hill behind the mine. The five floors are devoted:

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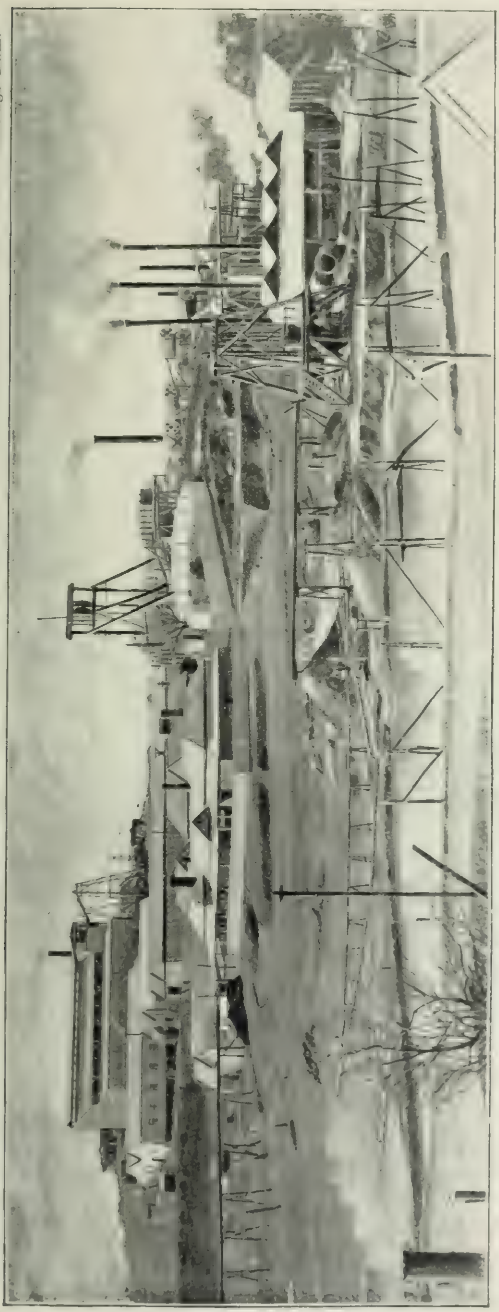
* The Choice of Coarse and Fine Crushing Machinery and Processes of Ore-Treatment, by A. G. Charleton; Trans. Federated Inst. of Mining Engineers, page 359 (Paper No. VII.).



GENERAL VIEW OF THE LAKE VIEW CONSOLS.

(1) To the Blake crushers, ore-bins, Challenge feeders, stamps and amalgamating table. (2) To grinding-pans. (3) To Frue vanners. (4) To amalgamating pans. (5) To settlers. The ore passes automatically from one stage in the process to another. The stamps weigh 900 pounds each, and the mortar boxes are fitted with inside-plates and use coarse screens to secure rapid discharge. The battery tables are 11-feet long, with a step of about 2 inches every 17 inches, a metal plate being set across the table at each drop to throw the pulp down vertically on the head of the plate below. The slope of the tables can be regulated by means of adjusting screws.

From the plates the pulp is conveyed by launders, fitted with corrugated copper riffles, to six Watson & Denny grinding pans, standing on a floor 5 feet below the tables, which grind the pulp to a finer size and their discharge passes to four Frue vanners on the next floor, which is 4 feet lower. The Frues yield concentrates containing 2 to 3 ounces of gold per ton, which are subsequently treated by cyaniding, whilst the Frue tailings pass through launders to four amalgamating pans, of the Wheeler class, which discharge into 8-feet diameter settlers set 3 feet below the pans; the refuse-slime from these latter going to settling pits, from which the clear water is pumped back into the battery storage-tanks.

The cyanide plant for treating the concentrates from the vanners consists of two solution tanks and two leaching vats, with zinc-boxes; the cost of cyanide treatment is stated* to be 8s. 9d. a ton. Mr. Bulman adds that actual figures over five months' working show an extraction of 90.8 per cent. of the gold contents. The average assay value of the ore milled (crushed chiefly for outside parties) was 2 ounces 3 dwt. 3 grs. per ton, and of the residual slimes, 3 dwts. 23 grs.; whilst the cost of milling (plate amalgamation, concentration, and pan amalgamation) ran from 14s. to 15s. a ton.

The Associated Mill:—This represents a type differing entirely from the two preceding ones, the oxidised ore being treated by dry-crushing and cyaniding. The stone from the mine is delivered to a rock-breaker at the top of the building, and thence into a sizing-trommel, which separates the fines from the coarse mill-rock. The fines are raised by a bucket elevator into a bin, and the coarse ore is delivered by automatic feeders to four Krupp ball mills, the product of which is raised by an elevator and joins the fines. The contents of the bin are discharged through canvas spouts into steel trucks (holding about 1 ton of crushed ore) which have W-shaped bottoms, the sides forming flap doors. Four or five of these tanks, placed end to end, are set on a carriage, drawn over the rails alongside the vats by an endless-rope, which can be started or stopped by a lever shifting the driving belt from a fast to a loose pulley.

The vats hold 160 tons, and it is claimed that by this arrangement the contents of the trucks are deposited more evenly over the area of the vats and no trimming is required. Two men fill a 160-ton vat in 8 to 10 hours. The residues are discharged through bottom doors into trucks below, and the charge is kept under cyanide treatment 10 days. During the year ending Aug. 1, 1898, it is stated that 20,519 tons of ore were treated in this mill, yielding 22,174 ounces, obtained at a cost of 18s. 2½d. a ton, of which 5s. 6d. a ton was chargeable to cyanide treatment.

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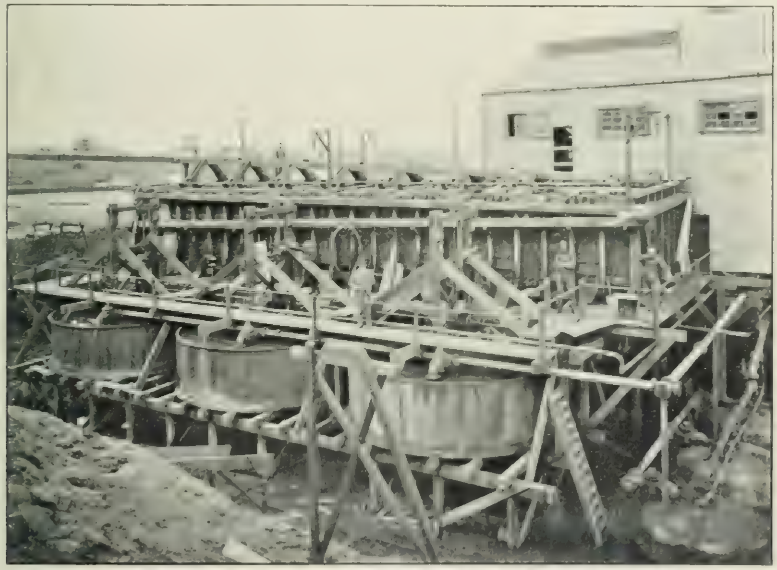
* H. Bulman. Trans. Am. Inst. of Mining Engineers.

The Brown Hill Mill:—The new mill erected by this company, which was under construction when I saw it in February, 1898, like the mill last described, employs the same general methods, viz., dry crushing* and cyanide, to the treatment of the brown-stone, but applies it in quite a different manner. Broadly speaking, the process as explained to me by Dr. Pape (the able metallurgist in charge of its erection), was to consist in drying the ore after it left the stone-breakers and crushing it in Krupp ball mills, sizing it with air-separators (which, judging by the products I saw in the laboratory, effect this object most satisfactorily) the coarse classified products being cyanided separately in steel-vats in the ordinary way, and the slimes being treated by agitation and filter-pressing. A marked point of difference between the Associated and Brown Hill method of treatment is that in the latter mill bromo-cyanide is employed as a solvent, in place of ordinary cyanide.



AGITATION VATS, CYANIDE WORKS OF THE IVANHOE BATTERY.

By adding roasting-furnaces, it was expected that this plant could be adapted to the treatment either of oxidised ore or telluride, but for reasons hereafter mentioned, table-concentrators in addition may probably be required to deal satisfactorily with the richer grades of sulphide ore. The Company's crushings from October, 1898, to September, 1899, amounted to 42,025 tons, which yielded 87,762 ounces 3 dwts. 9 grs.

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* Mr. James Parke has pointed out that in dry crushing ores in New Zealand, it is a curious and interesting circumstance that "the finer the dust, the higher its value," and the same thing has been remarked in dry crushing some of the Kalgoorlie ores.

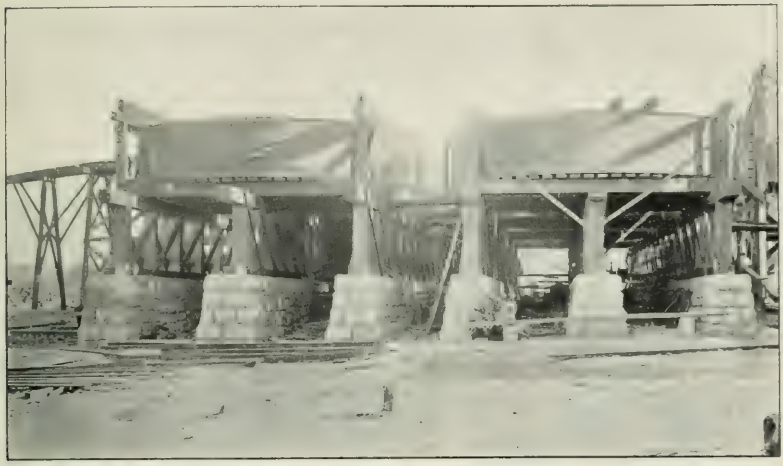
The Ivanhoe Battery, for a description of which I am indebted to Mr. Hewitson through the courtesy of the directors, contains 60 stamps driven by toothed gearing, provided with clutches for every 10 head. The ore is crushed in Gates crushers, and is delivered by an overhead tramway to the battery bins, from which it is fed to the stamps by Challenge feeders, the feeding stamp being No. 5. The ore is crushed through punched 16-mesh Russia-iron screens and the pulp passes over 12 feet of amalgamated copper-plates with a fall of ¾ inch to the foot, from which a distributing launder conveys it to canvas strakes, 50 feet in length, with a fall of 1½ inches per foot, which are swept down every hour with clean water. This keeps two men fully employed, and the concentrates collected, representing about 2 per cent. of the original ore, are stored and dried for subsequent treatment. The bulk of the mill-tailings is handled by a double 12-inch plunger tailings-pump. Mercury is added inside the mortar-boxes. The cost of mercury is reckoned at 2d. per ton milled.

The recovery by battery amalgamation in 1898 was estimated at 64.89 to 70.2 per cent. of the total gold, and in 1899, at 66.35 per cent. of the fine gold contents, 2.07 per cent. additional being recovered in the concentrates; the cost of milling in 1899, is officially stated to have been 5s. 0.836d. per ton of ore (4s. 3.85d. per ounce of bullion) calculated upon 59,664 tons milled, the costs being distributed as follows:—

1899.	Cost per Ton Milled. s. d.
Labour	1.7.338
Condensed Water	6.155
Salt Water	7.521
Tailings and Returning Water	4.388
Fuel	1.1.858
Quicksilver	1.213
Stores	0.919
Repairs and Renewals	7.444
	5s. 0.836d.

The treatment at these works on the whole closely resembles in principle that described at the Lake View.

The South Kalgurli battery is laid out on a somewhat different system, being designed to treat both oxidised and sulphide ores, which are kept separate in different bins, and pass first through a Gates crusher and then through Cornish rolls. Here the treatment of the two classes of ore diverges. The oxidised ore passes from the rolls



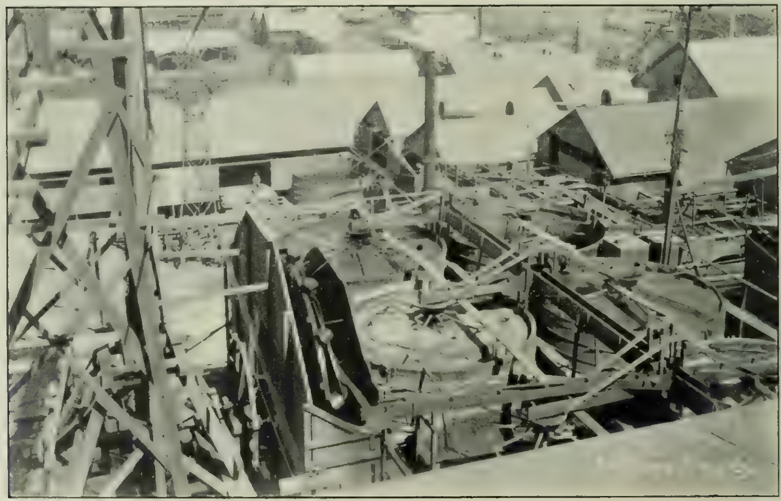
CYANIDE PLANT, NORTH BOULDER.

into wet-crushing Griffin mills, where part of the gold is recovered by amalgamation, and the pulp is afterwards run into grinding and amalgamating pans, completing this branch of the process. The sulphide ore, after leaving the Cornish rolls, passes through a rotatory drier and thence into dry-crushing Griffin mills, from which the ore is conveyed to a roasting furnace and de-sulphurised.

The Great Boulder Battery, for details of which I am indebted to Mr. Hamilton, through the courtesy of the Directors, contains thirty head of stamps, with copper-plate tables, six amalgamating and grinding pans, three settlers, and canvas concentrating tables; the system of treatment being somewhat similar to that described in use at the Lake View South. The stamps are in sets of five, and weigh 750 pounds. They are run at 80 drops per minute with an 8-inch fall, the order of drop being 1, 3, 5, 2, 4, and the capacity per head per diem 4.5 tons of oxidised ore. The mortars weigh 2 tons 5 cwt., and most of the gold is caught inside. The grinding-pans, employed to amalgamate the coarser particles of gold which escape the battery, are of the Watson-Denny type, and are run at 50 revolutions per minute and charged with two bottles of mercury each. The settlers which collect any amalgam or mercury that escapes from the pans are run at twenty-five revolutions per minute. The tailings pass over canvas-tables and are pumped into settling dams for collection and subsequent cyaniding. The loss of mercury is 0.425 to 0.470 ozs. per ton of ore milled.

The North Boulder battery building, besides the Huntington mills already described, contains an improved Blake stone-breaker, which cubes the ore to 2 inches, the grizzlies being arranged to correspond; also, ore-bins, two Challenge feeders, and ten 950-pound stamps of Fraser & Chalmers pattern, run at 80 drops a minute, with a drop of 4 to 6 inches.

They put through on the average about 2 tons per head per diem under these conditions, but if the output of the mine had been on a larger scale, by increasing the speed to 85, and the drop to 8 inches, keeping the discharge low, and using coarser screens, their capacity could without doubt have been largely increased—probably, indeed, doubled. The explanation why, apart from other reasons, early advantage was not taken of this obvious means of cheapening the cost of milling, was the fact that with slower drops and high discharge a higher extraction was secured. This, before the company possessed cyanide works, was a matter for consideration when dealing with rich ore.



CYANIDE PLANT, LAKE VIEW CONSOLS.

In 1898 the average yield of gold per ton milled was 19 dwts. 8 grs. and the average assay of tailings 7 dwts. 6 grs., showing an extraction by milling of 72.7 per cent., and as experiment has shown that about 16 per cent. of the gold remaining in the coarser sands is amalgamable, no doubt the extraction could be raised by amalgamation with finer crushing to between 80 and 85 per cent. of the total gold contents in the ore, but at the expense of a disproportionately increased cost. The following table shows the mill costs in detail in

1898 and 1899, when 10,150 tons and 9,772 tons were treated respectively:—

		1898, Cost per Ton of Ore Milled.				1899, Cost per Ton of Ore Milled.		
		s.	d.	per cent.		s.	d.	per cent.
Labour		3	8.510	43.61		3	7.060	36.91
Fuel		1	10.179	21.72		2	5.240	25.00
Water		1	11.777	23.27		2	2.830	22.94
Supplies.	d.				d.			
Screens	2.968				2.991			
Sub. oils	.465				.609			
Lighting oil					.715			
Mercury	1.740				1.253			
Chemicals	.375				.243			
Blankets	.391				.419			
Miscellaneous	1.999				.555			
			7.931	7.76			6.785	6.19
Tools			.153	.13			.505	.59
Repairs			3.570	3.49			10.490	8.97
		8s.	6.120d.	99.98		9s.	8.910d.	100.60

Milling 1,224 tons in October, 1899, the cost was, however, below these averages, viz., 7s. 9.82d. per ton, showing how largely the quantity milled affects the cost.

The Boulder Main Reef Battery contains a crusher and rock-bins, ten head of 950-pound Fraser & Chalmers stamps fed by automatic feeders, fitted with Blanton cams, and is furnished with blanket-tables for concentration.

For five months No. 1 battery worked with a front plate, whilst No. 2 battery was worked with both front and back plates in the mortar. Both batteries were furnished with lip plates. From the lip and back plates of No. 1 as much amalgam was obtained as from No. 2 battery. There was a marked improvement in the appearance of the lip plate of No. 1 battery without the front plate.

The amalgam obtained from No. 1 battery prior to the removal of the front plate on three occasions was from 1/10 to 1/15 more than from No. 2 battery. The distribution of the mill-costs shown in one month's run were as follows:—Mill, 3s. 8.6d.; steam, 4s. 6d.; water, 1s. 9.3d.; handling slimes, 1s. 4.1d. Total, 11s. 4d.

Tailings Treatment. Whilst the battery tailings vary considerably in value, it was found that it would, as a rule, pay handsomely to cyanide them; consequently most of the wet-crushing mills were early equipped with cyanide-plant for this purpose. The tailings not unfrequently contain some pyrites and a considerable quantity of black-sand, and carry up to 2½ per cent. or more of soluble salts—chloride of sodium and magnesium derived from the mill-water; hence the addition of a small quantity of slaked lime to the mill launders conveying the tailings to the dams may sometimes be beneficial, and a preliminary wash of weak caustic soda say (0.1 per cent. strength) may diminish the consumption of cyanide; the extractor boxes are not, however, kept in as good condition in this latter way as by using lime.

Sometimes, as was the case in South Africa also, large heaps of battery tailings (sands and slimes) were accumulated in the early days, in which event they need to be trucked from the heaps to the cyanide-works; but most mills are now treating their raw or green tailings direct, as they come from the battery. In the dams where they still carry a lot of water after settling, they present a dirty, muddy, gray appearance, but when dried, the oxidised tailings, are, as a rule, of a red-brown colour.

Whether owing to some difference in the character of the ore, as I am inclined to think is the case, or partly at least in consequence of difference in the treatment it has previously undergone, it is a well-established fact that whilst in some cases the slimes in the battery-tailings are comparatively high-grade, in others they are so poor as not to be worth treating, and this has led to two different lines being pursued in dealing with them.

In the one case, as at the Great Boulder, the dry tailings from the settling dams are trucked to the cyanide plant, which has a capacity of 200 tons per 24 hours, and both sands and slimes, after being broken up in a disintegrator, are run into a sump, pumped into a vat with radial arms and agitated with cyanide in these agitation vats to dissolve the gold. When this is done, the pulp is discharged into a montejus and filter-pressed, and the solution is passed through the extractor-boxes, and returned to the sump. The cost of this treatment in 1899, dealing with 23,707 tons, is given as 11s. 9d. per ton, which produced 10,193 ounces of bullion, 850 fine, the loss in the residues being 39 grs. per ton, and the consumption of cyanide 2.2 pounds.

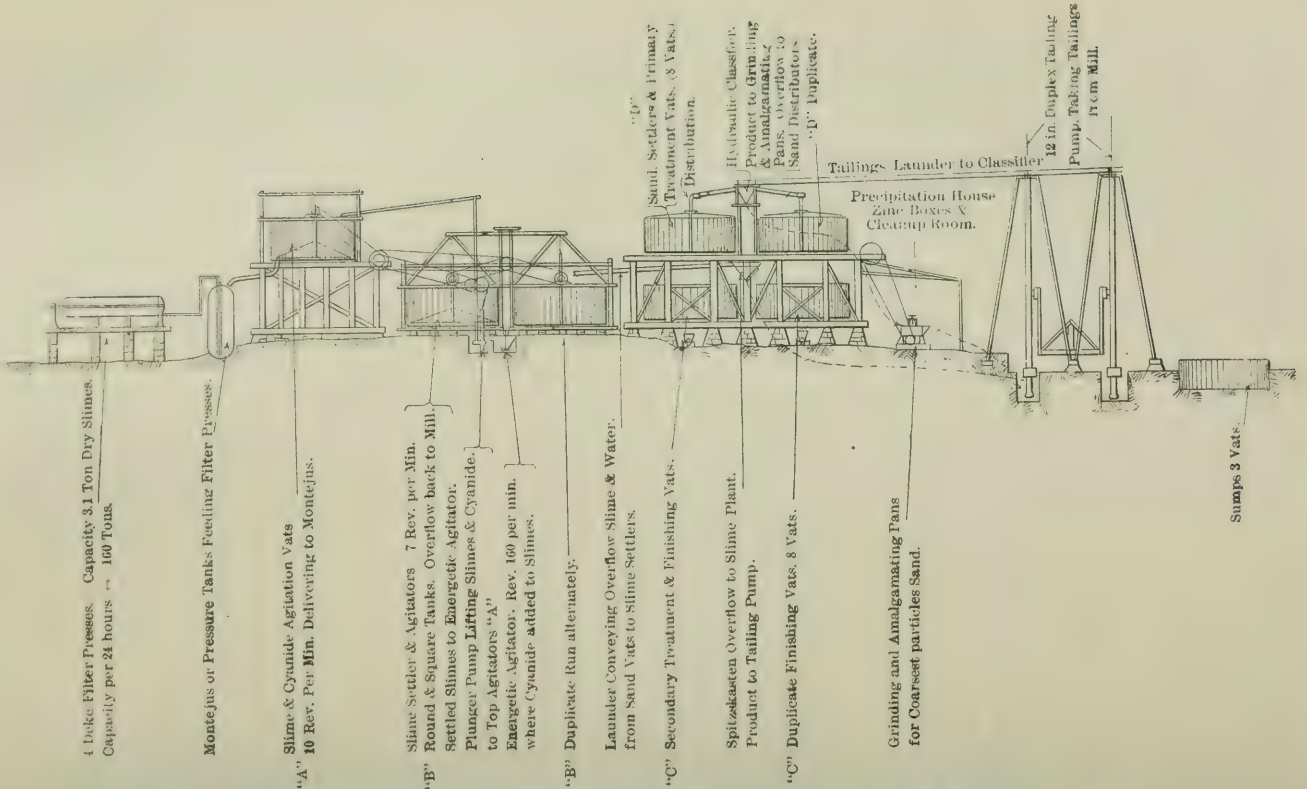
In the other case, as at Boulder Main Reef and North Boulder, the sands are separated from the slimes by settlement in one dam, and the slimes separated in a second dam, whilst the clear water flows to a sump, and is pumped back to be used over again. The sands thus collected are hauled to the cyanide plant, and treated by simple percolation, whilst the slimes may be regarded as worthless.

Handling the Battery-Tailings. Owing to the general flatness of the country, whether stored or treated direct the sands and slimes have usually to be elevated, and this is accomplished at the Great

Boulder Main Reef and North Boulder by means of tailings wheels, whilst at other plants, like the Ivanhoe, tailings pumps are used. The dams are formed of banks of dry-tailings, faced with sludge if the tailings are sandy, and are cheap to construct; but the arrangements for settling and clarifying the water are not, I think, generally carried to as high a pitch of perfection as in some other localities, notably Charters Towers, Queensland. The tailings wheels, a device familiar to old Freibergers, are, all, I believe, constructed with outside buckets; the one at the Great Boulder Main Reef (which I believe was the first one built in Western Australia) raises the tailings 18 feet. The German type, with inside buckets, has, however, several features to recommend it. The tailings-pumps, which are in common use for the same purpose, are able to lift the tailings to a much greater height than the tailings-wheels, and this is sometimes necessary. They are of the usual Australian pattern. I am not aware whether inclined Archimædian-screw centrifugal pumps have been tried for low lifts in this field, although they have been used, I know, for this purpose at Frieberg, at the New Central Aufbereitungs Works. Air-lifts, worked on the principle of the hydraulic elevator used in hydraulic mining, I am informed are employed on the Northern Goldfields, and there seems no reason why Pohle-pumps should not be employed.

The Treatment of Battery Tailings. At the Lake View the battery tailings, which contain about 80 per cent. of slimes, pass to a spitzkasten, the sands discharged from which are elevated by a tailings wheel to a set of six collecting tanks, with Butters' and Mein's distributors, which carry eight or more hollow radial arms, rotating in a horizontal plane above the tank on a central spindle. The stream of tailings delivered to them, falling into a cup-shaped receptacle, flows from the centre along the arms, and issuing at their ends, which are bent, causes them to rotate. The arms being of varying lengths (alternately long and short) the pulp is distributed evenly over the tank. The heavier sands which fall to the bottom still contain 40 to 50 per cent. of 100-mesh slime, and the lighter slimes escape through openings at the side which are closed by slats as the level of the contents of the tank rises. The sands are trucked to leaching vats in a separate building, at a lower level, where they undergo (according to Mr. H. F. Bulman) about 10 days' treatment, and the gold is precipitated on zinc shavings in the extractor-boxes. These contain a depth of about 16 inches of zinc, and are divided by transverse partitions into some ten consecutive compartments.

The slimes from the distributors, together with the slimes over-


4 Deke Filter Presses. Capacity 3.1 Ton Dry Slimes.
Capacity per 24 hours = 160 Tons.
Montejus or Pressure Tanks Feeding Filter Presses.
"A" Slime & Cyanide Agitation Vats
10 Rev. Per Min. Delivering to Montejus.
Slime Settler & Agitators 7 Rev. per Min.
"B" Round & Square Tanks. Overflow back to Mill.
Settled Slimes to Energetic Agitator.
Plunger Pump Lifting Slimes & Cyanide.
to Top Agitators "A"
Energetic Agitator. Rev. 160 per min.
where Cyanide added to Slimes.
"B" Duplicate Run alternately.
Launder Conveying Overflow Slime & Water.
from Sand Vats to Slime Settlers.
"C" Secondary Treatment & Finishing Vats.
Spitzkasten Overflow to Slime Plant.
Product to Tailing Pump.
"C" Duplicate Finishing Vats. 8 Vats.
Grinding and Amalgamating Pans
for Coarsest particles Sand.
Sumps 3 Vats.
"D"
Sand. Settlers & Primary
Treatment Vats. (8 Vats.)
Distribution.
Hydraulic Classfier.
Product to Grinding
& Amalgamating
Pans. Overflow to
Sand Distributor.
"D" Duplicate.
Tailings Launder to Classifier
Precipitation House
Zinc Boxes &
Cleanup Room.
12 in. Duplex Tailing
Pump. Taking Tailings
from Mill.

SECTIONAL ELEVATION, SAND AND SLIMES CYANIDE PLANT, IVANHOE GOLD CORPORATION, KALGOORLIE.
Capacity of sand plant, 8-day treatment, 120 tons per day; of slimes plant, 160 tons per day.

flowing from the spitzkasten, are settled in settling-tanks, and are forced by compressed air by a couple of montejuses working under a pressure of 70 to 80 pounds per square inch into ten Dehne filter-presses. The cyanide leaching solution is pumped through the cakes of slime and subsequently washed with water. The process occupies about four hours.

At the Ivanhoe, the battery tailings are first lifted to spitzlutten, which separate the coarser sands. These are run into grinding and amalgamating pans, after which they are passed through spitzkasten, the overflowing pulp from which, together with that from the spitzlutten, goes to the cyanide-vats. The Ivanhoe plant consists of sixteen 80-ton vats, placed in two series directly above one another, the lower vats being set about 5 feet below the upper ones. The vats in upper series are provided with Butters' and Mein's distributors, and are used both as settling and leaching-tanks, the slimes which overflow through adjustable sluice-gates (representing, it is said, some 40 per cent. of the battery-tailings) going to the slimes plant.

The sands, after the vats have been filled to the required depth, are drained fairly dry and leached for four days in the upper series of vats, then dropped through bottom discharge doors to the lower series, again leached for four days, and finally dumped through bottom doors into trucks underneath, and trucked to the mine for filling.

It is claimed for this double-treatment that it shortens the time of leaching from ten days to eight, the tailings being oxygenated and loosened in passing the sands from one set of vats to the other. The solution leaving the vats runs by a separate pipe from each vat to distributing launders, built of Kauri pine, each 20 feet long by 2½ feet wide and 2¼ feet deep, which deliver it to a double set of zinc boxes. Mr. Bulman states that in October, 1898, 120 to 140 tons of sands were being treated daily in this plant, with a staff of 13 men; its average capacity is reckoned at about 120 tons.

The cost of treatment is given me as 5s. 6d. per ton, including cost of grinding and amalgamating the coarse sands in pans.

The Slimes Plant. The slimes and water from the upper series of cyanide vats are run to a series of slime settlers; after settling, the water is run off and the slimes are passed through agitators with cyanide solution, the length of agitation being about eight hours. The slime and solution is then forced by a montejus, under a pressure of about 45 pounds per square inch, into filter-presses of Dehne pattern.

There are four of these presses of the frame type, with 50 chambers in each, 40 inches square, forming cakes of slime two inches thick. The slime thus collected, after leaching with solution, is washed with spent liquors whilst in the press, to displace any remaining gold solution, and this is again pumped through a smaller filter-press, containing 40 chambers 24 inches square, to clarify it before it passes to the precipitation department. The zinc boxes here consist of a double set, each being 20 feet long, 3½ feet wide, and 2¼ feet deep. The cakes in the filter-presses, after the gold has been dissolved out, are discharged into V-shaped side-tipping trucks, running underneath the presses, and are trucked to the waste dump.

The capacity of this slime-plant is 150 tons per diem, and the actual extraction of gold is, I am informed, from 80 to 90 per cent. of the gold contents. For cleaning up, sulphuric acid is used, and the gold is collected in a small clean-up filter-press.

The gold-slimes are melted in a tilting-furnace, in salamander retorts, 36 inches high by 23 inches wide, with a capacity of about 450 pounds weight of gold-slimes, and the whole clean-up (usually over 3,000 ounces) is melted and run into bars in about four hours.

The extraction calculated on the "fine gold" recovered by the Ivanhoe process, is estimated as follows:—

	1898.		1899.
By Battery Amalgamation	68.3 per cent.	to	66.35 per cent.
" Concentrates Treated	1.7 "		2.07 "
" Cyanide Treatment	22.3 "	Sands	13.85 "
		Slimes	8.46 "
Total Extraction	92.3 per cent.		90.73 per cent.

Value and Fineness of the Gold. Baron Oldruitenborgh states that the value of West Australian gold varies within broad limits. Gold produced from quartz veins, which is, as a rule, more or less argentiferous, is worth from £3.8 to £4.2 per ounce whilst the gold obtained from the formations has a value of £3.18 to £4.4 per ounce. The general average is about £3.15. Mr. Wm. Frecheville considers the average value of Kalgoorlie reef gold as being a little over £4 per ounce, but the bullion varies somewhat in fineness, depending on the method employed in its extraction.

LESSONS FROM THE EXPERIENCE OF BRITISH ORGANISED LABOUR.

By F. Brocklehurst.

The Engineering Magazine has often and clearly expressed the belief that organisation, actuated by justice and common sense, is a movement of the utmost promise for promoting mutual comprehension and harmony between employers and employees. The tangibility, accessibility, and responsibility which association gives to otherwise indefinite and incoherent elements make it the very best medium for spreading knowledge, presenting argument, and inducing wise action. It is with sincere desire to aid the leaders of thought to the choice of aims which will succeed—away from efforts which will fail, because contrary to the genius of evolution—that this analysis of the record of Britain's great labour union is presented. Their own history furnishes the experimental demonstration most instructive to labour leaders everywhere—The Editors.

THE concluding words of the Jubilee Souvenir of the Amalgamated Society of Engineers, which has been compiled by G. N. Barnes, the general secretary, run as follows:—"We have endeavoured in these pages to set out, without colouring or comment, a plain and unvarnished tale of the society's origin and subsequent proceedings, hoping and believing that its perusal will assist the members in making straight the paths leading to the society's greatest possible usefulness." It is much to be hoped that the members of the society will take to heart the suggestion thus conveyed, and that they will themselves add the "colouring and comment" necessary to make the Souvenir of real benefit to themselves and the whole engineering world. The little booklet published with the object just described is as much a serious warning as an encouragement, though probably little intended to play this dual *rôle.*

The Amalgamated Society of Engineers have certainly reason to be proud of the success which attended the efforts of the early pioneers towards unity in the engineering industry. Out of the scattered forces of trade unionism, they have welded together a federation second to none in the world; and their continued growth in numbers, in influence, and in financial value, can only be described as phenomenal. Honourable again is their association with the agitation which preceded the granting of the nine-hour day; and in the names of Allan, Newton, Rowlinson, Burnett, Gourlay, are represented successive movements each of which contributed to the prosperity and permanence of their society. It is also to the credit of the association that it has continuously avoided the pitfalls which surround the question of co-operative workshops. Although a proposal to invest their surplus funds in this manner was recommended originally by the leaders of the society and popularised by an essay from the pen of Vansittart Neale, a full discussion of the question "killed it," though appearances of its resurrection afterwards are given in the Souvenir at recurring intervals. These are some of the things of which the engineers may be justly proud, but there is a contra account meriting special attention.

The record of the society's history bears traces of the struggles which frequently occur between rival trade unions over questions of demarcation of work. The subject is too well known to require extended treatment in this article. Sufficient only to point out that the danger of trade dislocation and loss from this source still remains, and that it is high time that authoritative boards were constituted by the societies interested to which all such questions could be referred for settlement. So far as can be gleaned from the Souvenir the society never appears to have taken a very strong line respecting non-union labour. In the latter part of 1896 seventy members struck work "against the employment of a non-union workman who had made himself obnoxious," but inasmuch as this action was determined upon without the prior knowledge of the executive committee, they were refused strike pay and advised to return to their machines. The trouble ended by the withdrawal of the workman objected to. A delegate meeting of that year passed a rule, however, which provided that "members should be entitled to contingent benefit if they left their work rather than work with non-society men." As is already well-known, the matter was finally settled at the close of the great engineering dispute in 1898 in the clause of the agreement which provides for "Freedom of employment." In returning to work under this the engineers bound themselves to acknowledge the freedom of the employers "to employ any man whether he belong or not to a trade union." Judging, however, from the history of the society as recorded in the pages of the "Souvenir," these have always been considered to be subsidiary questions. The greatest of the society's battles have been fought around the issues raised with respect to overtime, apprentices, piece-work, and control of machinery; and it is not without significance that, after struggles extending over half-a-century, the Amalgamated Society of Engineers has been compelled to acknowledge defeat with respect to every one of them.

One of the movements which directly contributed to the formation of the amalgamation had for its object "the curtailment of overtime and the reduction of hours in the London district." The first clause in the general pronouncement which issued from Birmingham in 1850 states: "We repudiate systematic overtime," and it threatens any member of the amalgamation refusing to comply with the then-declared policy with "liability to be excluded from the society." On submission to the members the vote against "systematic overtime" was carired by 5,709 to 16; but when the question was tested in battle with the employers, the latter, after a lock-out of several months' duration, gained the day. In the words of the Souvenir, "the dispute fizzled out." Forty-five years afterwards the Society recommended a set of regulations for overtime which had previously been acceded to by Messrs. Platt of Oldham. In these regulations provision is made for "systematic overtime" at the following rates of pay: "Time-and-a-quarter for the first two hours, time-and-a-half for the second, double time afterwards; and for pieceworkers an addition equal to the difference between overtime and ordinary rates." The settlement of 1898 recognised "systematic overtime" to the extent of no less than 40 hours per month, and "unrestricted overtime" in certain special cases.

If we turn to the question of apprentices we are met with a similar picture of a struggle resulting in ultimate and even more crushing defeat. The amalgamation adopted as its initial policy the restriction of apprentices "in proportion of one to four journeymen." The terms of the 1898 settlement declare that "there shall be no limitation to the number of apprentices," and the "note" is added that "this merely puts on record the existing practice." That is to say, the original policy of the society had to be abandoned as the result of practical experience. This result was not however achieved without some struggle. The Souvenir contains a record of a dispute which arose in Sunderland in 1883 respecting "the regulation of apprentices." The following is an exact copy of the concluding words in which the strike is described: "For the purpose mainly of this dispute, a levy of 3d. per week was maintained for a very considerable time, but the strike, notwithstanding, was a dismal failure, and tapered off to an unsatisfactory conclusion only when the men were dispersed elsewhere or absorbed in Sunderland under the old conditions, and after an expenditure of over £100,000."

The history of the disastrous opposition to the introduction of piecework can best be told in the words of the Jubilee Souvenir itself. The original rules of the amalgamation contained the following injunction: "That steps be taken to abolish piece-work." A vote of the members showed 5,297 against the practice, while only 18 were in its favour. This, together with the question of "systematic overtime" formed the officially recognised causes of the dispute of 1852, which, as we have already been informed, "fizzled out." At the delegate meeting of 1874 "a new rule was inserted laying down the conditions on which members could work by the piece," and this was afterwards remoulded in the delegate meeting of 1892. These concessions to the absolute necessities of the engineering industry did not, however, prevent members of the society undertaking strikes "against the introduction of piece-work." In 1875 a strike was conducted against piece-work at Erith "which dragged its weary length along to an unsatisfactory conclusion in May of the following year (1876)." And again: "The outstanding feature of the year 1890 was the strike against piece-work at the shops of the Maxim-Nordenfelt Company, at Erith, which began in November, 1899,.and continued till September of the following year. In the abstract report issued just afterwards, the Council said: 'Not in the history of the society were ever arrangements so complete with a view to bringing a strike to a successful and rapid termination. Every member of the society, and those of the steam-engine makers, left. For the first time in a strike, all foremen were withdrawn, old and young, but without effect, as ultimately the strike was a failure in spite of liberal pecuniary support tendered from our trade fund and from voluntary subscriptions.' It should be here said," continues Mr. Barnes, "that this strike was also noticeable by the fact that the members of the Gas-Workers' Union had turned out in support of the engineers, and granted money towards the expense of the movement." The climax of the agitation was reached in 1898, when the society had to confess itself utterly beaten. The first line of the clause of the agreement relative to piece-work runs as follows: "The right to work piece-work at present exercised by many of the Federated employers shall be extended to all members of the Federation and to all their union workmen." Further comment is unnecessary.

The great struggle of the Amalgamated Society from the date of its formation down to the present time has been concerned with what is generally described as "the machine question." It is the one which occurs with greatest frequency in its history. The attempts of the engineers to control the machines have not, however, been crowned with success. With the exception of a partial triumph over Messrs. Hibbert, Platt & Sons, of Oldham, in 1851, the whole movement appears to have been a dire failure. The great lockout of 1852 originated primarily in a dispute with the Messrs. Hibbert & Platt, aforementioned. This firm, under pressure, it is said, assented to conditions of employment which embraced, *inter alia,* the following: "That in future the machines be worked either by mechanics or apprentices, to be taken up by them as they fall vacant," and "that the labourers be not unduly interfered with before Christmas, 1851, when the machines shall fall entirely into the hands of the mechanics, but if any of the labourers are discharged or the machines otherwise become vacant, the vacancies shall be filled up by the mechanics as they occur." This agreement was but of short duration, and in the following December the employers banded themselves together and determined to support Messrs. Platt by means of a sympathetic lockout if the demands of the engineers were persisted in. These, if we are to accept the statement put forward by the employers on this occasion, appear to have been as follows: "That all the men now working at planing machines be discharged and their places supplied by mechanics belonging to the trade union." This stringent policy of the Oldham men never seems to have met with the sympathy of the executive committee of the society, and they issued a note to the employers to the effect that they had neither "demanded the discharge of persons at present working self-acting machines, nor was it their intention to do so." "But," so the record runs, "all this was of no avail, and the society was held responsible both by employers and the public for the . . . claim in reference to machines." Although defeated on that occasion, the engineers' society has never yielded its claim to the control of self-acting machinery. Even at the present day it is one which is frequently urged by the delegates in the several districts with consequent friction and trouble. This is one of the questions, however, on which there appears to have been a continuously divided opinion between the rank and file of the members and the executive committee of the society. Coming as far down as 1897 we find that a strike took place at the Pallion Forge, Sunderland, against "horizontal boring lathes . . . being manipulated by handy men." A conference was held between the executives of the employers' federation and of the trade society, when the officials put forward the suggestion that "a mutually satisfactory solution of the difficulty is to be found in local committees, with a reference to the Board of Trade, such committees to decide—having due regard to class of machine, quality of work, and standard rate of district—upon the wage to be paid." These proposals were, however, rejected, and the machines were restarted on the lower rate, the men at the same time being induced by the council to remain at work. Several disturbances of a similar character broke out during the early summer of the same year; and in every one of them the members of the executive committee were against the men in their demand to make the differences a cause of industrial war. The London movement in favour of the eight-hour day intervened, and this was made the occasion of the great trade struggle which resulted so disastrously for the engineers' society in January, 1898. Under the head of "Selection, Training and Employment of Operatives" the terms of settlement contain the following clause: "Employers are responsible for the work turned out by their machine tools, and shall have full discretion to appoint the men they consider suitable to work them, and determine the conditions under which such machine tools shall be worked."

Such, in brief, is the history of the Amalgamated Society of Engineers in its relation to the questions of overtime, apprentices, piece-work, and the control of improved machinery. The experiences of the past fifty years will have been utterly wasted if the society continues a policy over which the word "Failure" is writ large. The apprenticeship question seldom, if ever, agitates the members of the society nowadays; while that of overtime is already provided for and, in the main, is accepted. Piece-work and the control of automatic machinery are the two burning issues, the fires of which have by no means been quenched by the agreement of 1898. A glance at the *Monthly Journal,* issued by the society, serves only to show that the engineers are still opposed to the introduction of the piece-work system, and that they are constantly setting themselves against the custom, which is evidently growing, of putting "handy-men" to watch automatic machinery. In a series of articles recently published in the *Manchester Evening News* (January 19, 26, Feb. 2, 9, 16), I have given reason to believe that in taking this course they are on lines which must inevitably land them in further disaster. At the risk of appearing to be unduly assertive, I venture to quote one or two sentences from those articles. They are as follows: "It is useless for us to blind ourselves to the fact that between the engineers and their employers another test either of strength or diplomacy is inevitable. . . . What are the engineers going to fight about? For the right to handle improved machinery? They have already lost this battle, and if they should ever be so ill-advised as to enter upon another conflict for the purpose of reversing the verdict of 1898, I venture to prophesy that they will be worse beaten than they were then. Time and science are against them. The only issue upon which they can win is the one of wages.

DISCREPANCIES OF PRECEPT IN MACHINE DESIGNING.

By Leicester Allen.

Not long since, allusion was made in these pages to the settled principles of machine designing which had been found to satisfy "all the conditions there are," and therefore were accepted in both theory and practice. Mr. Allen shows how far this status is from being universal.—The Editors.

SUBJECTIVE knowledge has been defined by an able logician and profound thinker as "the highest degree of certainty of which the mind is capable," and science as a system of classified knowledge and logical deductions from the facts included in classified knowledge. If knowledge be deficient, if strict lines of logical reasoning be not adhered to in deducing conclusions from orderly arrangement of facts, or, as sometimes happens, if deficient data are made the basis of illogical reasoning, we are at once led astray. Conclusions reached by mathematical methods, on account of the rigidity with which mathematics holds the reasoning faculties to lines of logic, are more readily accepted than those of pure deductive logic which excludes all ideas of quantitative relation.

The fact is, however, that two "ifs" always enter into mathematical reasoning. The conclusions finally arrived at are correct and reliable *if* the data upon which the operations proceed are really facts, and *if* no error has entered into the operations. To arrive at the highest degree of certainty the data must have been determined by methods, experimental or otherwise, such that the mind is compelled to accept them as true, and the mathematical operations must be scrutinized and tested till the mind is also forced to accept them as perfectly accurate. All element of doubt must be removed, for doubt does not, cannot, exist in any conclusion which can claim to be knowledge. If any residuum of doubt remains, conclusion sinks to the level of probability, or to the still lower level of possibility, and may fall still farther to mere guesswork. If a designer base his design upon average strength of material, how can he know that, in construction, a material of lower strength may not be employed, perhaps the most inferior of its kind? But if in the design a material of known strength and quality be specified, and if the designer knows the strains to which this material will be subjected, he may, if competent, proceed with confidence and rely upon the adequacy of his work when done.

In mechanical engineering most of the data have been obtained from experimental investigations, and all designers, though they may be experimental investigators themselves, are obliged to accept the most of their data on authority. To satisfy themselves as to the reliability of facts determined by experiment and authoritatively stated, they usually examine the methods of performing experiments, and if these appear accurate, and the results are stated by experimenters accepted by the scientific world as competent to determine and state facts with equal accuracy, the results are not questioned, because the mode of experimenting and the reputation of the experimenter inspire implicit trust. The highest degree of certainty may inhere in the authoritative statements of results by renowned and skillful investigators and such statements may be accepted with so little reservation as to raise them above the level of mere probabilities. But when authorities of equal and high repute disagree, when the data and formulæ given by them do not attain uniformity, or even approach to uniformity, what is the designer to do? Shall he not only base his design upon average strength of material, but also take an average of the results of various formulæ, and from these formulate new rules and equations differing from some or all of those previously given? And, if he does this, can this in any sense be called a scientific method? And does not the widely differing practice of leading manufacturers show plainly that mechanical engineering, notwithstanding its great achievements and successes, has not yet reached a truly scientific plane?

Compare it for a moment with some other science—say chemistry. Chemistry, although, some differences of opinion yet remain upon theoretical points, is in its practical operations reduced to a substantial uniformity. Let one thousand chemists scattered in a dozen different countries essay to form a certain chemical compound, they would each take the same weight of the separate reagents necessary to form the given weight of compound, would put them together in the same manner, perform substantially the same manipulations, and each have at the end a product uniform in weight, physical and chemical qualities.

Suppose now that one hundred competent men were asked to design independently, a vertical, triple-expansion, condensing, pumping engine having piston valves for high-pressure and intermediate cylinders, with slide valve or valves for low-pressure cylinder; to take steam from boiler space in which pressure of 180 pounds is maintained; inducted steam to contain 10 per cent. of its weight of water; condenser pressure 4 pounds per square inch; piston stroke 72 inches; number of revolutions per minute to be 30; useful work to be 2,000 horse power; efficiency of engine to be not less than 85 per cent.; steam consumption per indicated horse power per hour not to exceed 12 pounds.

It will be noted that two of these specifications are elastic, the efficiency may be stretched upwards, the steam consumption downwards.

How many of the engines designed would exactly meet the specifications? How nearly would they look alike—how nearly weigh alike—how nearly cost alike if all were constructed by the same builder—how nearly work alike? Their proportions and weights would differ. Some would reach the required economy at one speed, some at another. Reaching the economy of steam consumption specified, some would fail in the stipulated efficiency of the engine. Each would be a law unto itself, but, in advance of trial, the law could not be precisely stated. The engines would no more be alike than a hundred different men selected from their general resemblance to each other. The most of them would be, scientifically considered, only coarse approximations to the stated requirements taken as a whole. And this would not be the fault of the designers. We shall, by roughly going over the progress of the work of designing, easily find the cause of their discrepancies.

In the first place, all the data relating to the properties of saturated and superheated steam the designer finds well-determined and conveniently tabulated; but, as he has to deal with neither one nor the other, but a mixture of steam with 10 per-cent. of water, this tabulated information does not apply directly to the case he has in hand. He would like to draw curves representing pressure and volume as a basis for computing mean effective pressures in the three cylinders, and in searching for a mode of doing this, he finds the exponential equations of Rankine, Grashof, and Zeuner, finds that the exponents differ, and finds that they do not represent the actual relations of pressure and volume in a steam cylinder of any available material. He finds that the adiabatic curve of pressure and volume is a still worse representative of what actually takes place in a steam cylinder, and further, that while a few determinations of curves obtained from steam mixed with stated percentages of water have been made, they have not all been made with such rigid care to eliminate error, and have not been repeated by different investigators sufficiently to establish them as scientific and reliable working data. So he draws the isothermal curve, knowing this also to be wrong, but different authorities state percentages of allowance for error in using this curve. By making such an allowance he arrives at an assumed mean effective pressure from which he is able to deduce, with more or less inaccuracy, the diameters of the high-pressure cylinder and its co-operating cylinders which shall deliver under the stated conditions the expected horse power, after having first decided upon the matters of cylinder ratio, clearance, lead, and compression. On these four points he will again find plenty of conflict.

As to clearance and compression, most of those who will see this article will have already read Mr. Suplee's admirable summary of the present status of discussion and opinion on the subject, being the last article in the "Review of the Continental Press" in the April number of THE ENGINEERING MAGAZINE. Nothing could better illustrate the uncertainty which the opinions of this array of high authorities would create in the mind of the designer seeking light to guide him in his practical work. Doubtless the majority of the hundred designers selected would fall back upon the still prevalent doctrine that clearance, large or small, is a source of loss, the larger the clearance the greater the loss; and, having fixed upon the smallest practicable clearance, would next consider the cylinder ratio and points of cut-off. On the subject of cylinder ratio there is also a wide divergence of practice as well as theory. Seaton, an eminent authority, says:

"Like so many other matters in marine engineering, the questions of the best proportions and arrangements of cylinders are still open, and matters of opinion, and the most successful practice is that in which *the best compromise* between conflicting conditions has been effected. "The chief point at issue * * * * is the best ratio of cylinder capacity. * * * * There is necessity for exercising a considerable amount of discretion in fixing on the ratio." *

But when lead has to be considered, the designer finds himself still floating on his discretion without any guide, and in the hundred designs we shall find leads of from 5/16 inch down to no lead at all.

But, waiving further consideration of the uncertainties that beset the designers in their attempts to meet the requirements of the specifications as regards performance after the engines are built, let us pass on to parts wherein the theory of the engine has to be very little considered or not considered at all.

As to thickness of cylinder and liner, taking the formulæ of each of a dozen accepted authorities, he will get, for the same conditions of power, mean effective pressure, revolutions per minute, stroke, etc., a difference between the higher and lower result of over 92 per cent. of the lower. The thicknesses of cylinder heads will range from higher to lower through a difference of over 35 per cent. of the lower. Some of the authorities favor, while others object to, strengthening webs for cylinder heads. Following the same authorities he will find for piston heads a difference of thickness between the higher and lower result of over 122 per cent. of the lower. Computing for iron piston rods, from the higher to the lower diameter, he finds a difference of 75 per cent of the lower. Kent, in his Mechanical Engineer's Pocket Book, says: "There is perfect agreement among the authorities as to the formula for area of slides * * * * but the allowable pressure" (given by these authorities) "per square inch ranges all the way from 35 pounds to 500 pounds." There is greater uniformity in formulæ for connecting rods, but as the formulæ are given for different strokes and different lengths of connecting rods, it is observable that the formulæ of some authorities give larger diameters for short than for long stroke engines, while others give exactly the reverse. As to crank-pins, in the matter of their length, a difference of 33 per cent. of the length of the shorter is found in the longer as obtained by the formulæ. A difference of over 33 per cent. will be found in diameters. Very little discrepancy is found in formulæ for crank-arms. For fly-wheels a great variety of formulæ exist, and the variation in diameters and weights resulting from their use is material; but space enough has been absorbed in exhibiting discrepancies.

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* It is stated by Mr. H. H. Suplee (Trans. A. S. M. E. x 583) that an examination of fourteen quadruple-expansion engines working at an initial pressure of about 180 pounds per square inch discovered an average ratio of nearly 1, 2, 4, 8.

Kent, above quoted, sums up the whole matter as follows:

"The treatment of this subject" (dimensions of parts of engines) "by the leading authorities on the steam-engine is very unsatisfactory, being a confused mass of rules and formulæ based partly upon theory and partly upon practice. The practice of builders shows an exceeding diversity of opinion as to correct dimensions."

Our supposed designers then, in commencing their work, will plunge into a sea of uncertainty if they attempt to follow authority, unless they accept and blindly follow one sole authority. Some will assign average values to constants, and adopt formulæ which give an average of results obtained from the formulæ given by the authorities. The more experienced, however, will turn to their note books of former practice. These note books contain the records of the make-shifts and compromises by which they have been able to surmount, in some passable way, the difficulties and perplexities of past experience and form rules for individual guidance, whether these rules would be acceptable to others or not. They have become self-reliant, and will follow no authority blindly nor accept implicitly from all the authorities anything that has not been confirmed by their own practical work.

But is this state of the art of mechanical design as indicated worthy the name of either knowledge, or science, and is it not time in this twentieth century, that engineering and mechanical data should be sifted, classified, tested, the defective discarded and the good retained? Surely there must be some radical fault which leads to such a result as that two different designers should, for the same engine or same cylinder, fix upon sizes of piston rods of the same material one of which shall have 75 per cent. larger diameter than and weigh three times as much as the other.

I have simply selected the design of a steam engine as that which perhaps best illustrates a general fault in the entire field of machine designing, to wit, lack of exact data and uniformity of rules for computation. The fault is, I think, more pronounced in engine designing than in any other field, and so long as it is attempted to supply the want by independent discursive effort, the status will not be essentially different.

Mechanical engineers must agree to adopt a fixed factor of safety, prescribed by some authoritative source which will be universally accepted. They must cease to apply formulæ to materials of widely varying strength, as though all were equal in value for a specific constructive purpose. Why should a hard-and-fast rule be applied to determining dimensions of any part of an iron structure, without any knowledge of the test strength of the iron? No formula can be scientific in which an average strength is made an element. Given precise knowledge of the strength of the material used, and of the strains to which it will be subjected, the calculations of its dimensions, allowing a reasonable factor of safety upon which all might agree, would present no difficulties and involve no uncertainties. If it be said we do not know the strains, it may be replied that before mechanical enginering rises to the plane of science we must and shall know them. The present movement to establish a National Standardizing Bureau in the United States is a well-directed effort and should receive the support of every engineer and manufacturer. When established it should cooperate with similar bureaus already existing in European countries, and it is not too much to hope that ere many decades close, an international bureau fitted out for investigation in all branches of engineering shall supply tabulated data which, used in a uniform manner, will entitle mechanical engineering to be called a science as well as an art.

EDITORIAL COMMENT

THERE have been many remarkable strikes instituted at one time or another by labour organisations whose aggressiveness was larger than their wisdom or reason. In one recent American instance certain workmen struck to get themselves discharged. They were non-unionists, hired to fill out a force of union workmen, and when the unionists went on strike in protest against this engagement of outside labour, the non-organisation men who were the cause of the trouble enthusiastically walked out—"in sympathy."

The proposed strike of the British coal-miners against Sir Michael Hicks-Beach's export tax of a shilling per ton would have been scarcely less incredibly absurd. They have abandoned the intention for the present, according to statement, on the assurance that "the foreigner will pay the tax," but they will reconsider their agreement to work should this not be proved. The presumption is that if the foreign buyer will not pay the shilling, they would prefer that the foreign seller should capture the export market—for that would certainly be the result of a serious strike in the British coal mines. The likelihood of America's capturing a large share of the European coal business may not be as imminent as some have recently predicted; the fact that Britain held her own in the face of an advance of very many shillings a year ago indicates that one shilling is a wholly inconsiderable matter; but with Britain's output cut off, her customers would be compelled to make new arrangements, and once sent "over the way" would never again reopen dealings on the former scale.

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THE ENGINEERING MAGAZINE was the first to preach the universal importance of industrial matters, and to demonstrate the wonderful responsive interest in the intelligent and authoritative presentation of the facts of engineering progress and the study of the best methods and management. It has been a leading influence in the reorganisation of productive industry necessitated by the wonderful expansion of the last decade—in awakening the leaders of industry and its commercial and financial copartners to the necessity of extending their observation to an international range, and of improving their practice by the adoption of the best methods anywhere discoverable. And this influence is reflected throughout the periodical press, popular as well as technical. Even the "literary magazines" have discovered the general demand for information on subjects which at one time they would have considered wholly technical, and left for treatment by the engineering press in a wholly technical manner addressed solely to the specialist, and often incomprehensible even to the engineer in a closely affiliated line. The fact that many of the subjects were of vital importance to every one concerned in material progress—which means practically all civilisation—and should be clearly presented in plain language comprehensible to every intelligent understanding, remained to be demonstrated by the remarkable success of this effort.

An examination of the files of any of the magazines in the literary field will reveal a large and increasing number of articles devoted to subjects at least semi-technical in character. The tendency is admirable, but unfortunately the treatment too often lacks the most desirable element of accuracy. If an article sounds "learned" it is passed by the editor with an implicit acceptance which he would not think of extending to cover statements in history, biography, or letters. It would seem that if the thing were worth doing, it was worth doing well, but too often it is so done that it provokes amusement—or some less kindly feeling—from those who should be most interested and appreciative. Even so ably and admirably conducted a magazine as the *World's Work*, in an article on the long-distance transmission of electrical power, speaks of "getting 10,000 volts from the Big Cottonwood," "adding 16,000 volts to the available supply," "sending 10,000 volts into London" or the Rhine "yielding 16,500 volts at Rheinfelden," as if the volt were a unit of power instead of a unit of pressure. In fact, this seems to be the confusion existing in the author's mind, for the Rheinfelden plant develops 16,000 horse power, which is transmitted by a current of 6,800 volts and 80 amperes.

The point is not merely captious. Such papers, if correct, are widely educational. If not worth the pains necessary to make them correct, they would at least be better for the omission of expressions which are meaningless to the layman and, as thus incorrectly used, uninstructive and absurd to the professional.

* * *

Trust formation, which for some months in the United States had experienced a period of comparative quiet, has been started into new fermentation by the launching of the United States Steel Corporation. The air is full of announcements and rumors of consolidations. Not content with home worlds, the magnates are going abroad to conquer England and the Continent, and all the world is to be one great combine. There is to be no place any more for competition, according to the promoters, and yet under their very shadow competitive concerns are starting up. It is painfully hard to eliminate one of the elemental principles of life, and what kind of a state would remain if this one could be eliminated? Something less than life as it has always been known.

Hasty advisers have clamoured for British iron masters to meet the trust by counter-combination; it is indubitable, however' that their present unfavourable position is due, as averred by Mr. Garrett at the recent meeting of the Iron and Steel Institute, to too little competition in the past. The shock of the sudden awakening they have just experienced may be the beginning of their salvation. It is by rivalling the United States in the fearless pursuit of economic methods, the study of intensified production, and the adoption of improved machinery, however, that they will rise to new industrial ascendancy—not by venturing in the untested and dubious pathway of "regulation instead of competition"; by following the example set in the past by Carnegie, not the dazzling but unproved prospectus held forth by Morgan.

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The interesting and widely read articles on Russia, which appeared in this Magazine in February, March, and April, will be resumed in July after an unavoidable interruption caused by the pressure of Mr. Ford's business engagements. The concluding article will deal particularly with Russia as a market for machinery and especially machine tools. It will actually gain in effectiveness by the postponement, as Mr. Ford has been enabled to study and determine with reasonable definiteness the actual effect of the tariff reprisal measures directed by M. Witte against the United States, under the provocation of Secretary Gage's imposition of "countervailing duties" on Russian beet sugar going to America. While Mr. Ford is a firm believer in the mutual profit and splendid future of Russo-American trade relations, and does not believe the amount of American export manufactures finding their way to Russia will be very greatly diminished by the "tiff," he indicates that the immediate relations heretofore existing will give way for the present to indirection and "underground" methods which will certainly be to the disadvantage of the United States manufacturer and will play into the hands of his English and German competitor. The paper will be the most interesting of the group.

REVIEW OF THE BRITISH PRESS

Modern Artillery.

A very interesting paper on "Modern Artillery," by Lieut. Arthur Trevor Dawson, appears in the *Journal of the Society of Arts.* While limited by its author's preface to a comparative examination of certain types of ordnance, British and foreign, with a view to examining specific differences and relative advantages, it affords a remarkable demonstration of the extent to which military engineering has drawn upon the civil branches of the profession for its recent advance. Modern artillery owes the greater part of its efficiency and accuracy to the genius of the mechanical engineer. Hydraulic, pneumatic and electric appliances bring the ammunition to the modern large gun, load, lay and train the piece, and take up the recoil. The improvement of mining practice has furnished valuable help in the search for low-temperature and high-power explosives; the metallurgist has contributed the materials necessary to meet the difficult requirements; and all this aside from the admirable mechanical skill developed in the design and construction of the ordnance and its auxiliaries.

The resultant is that, as in every other use of mechanical construction, the type of a very few years ago is obsolete, and the old so hopelessly inferior to the new that its retention means loss of supremacy. Lieut. Dawson points out that even the Inflexible, heading the list of Royal Navy vessels armed with muzzle loaders, with her 485 men, if opposed to a French cruiser of the Cassard class, with but 385 in her crew, but with modern guns and telescopic sights, would be helpless at 8,000 yards or beyond. Yet at this range the French ship "would be able to make good practice," and in the Lieutenant's opinion would put the British ship quickly out of action. This affords excellent reason for either selling the old ships or giving them modern armament, and Lieut. Dawson favours the latter course, believing they would be of value in the reserve. He advocates that every vessel of British registry over 3,000 tons and 17-knots speed "should be called upon to have suitable deck attachments for the accommodation of 6-inch quick-firing guns," believing strongly in the efficacy of the unarmoured ship of great speed and high gun power, which can control her range.

First in importance of the factors in the improvements of modern artillery Lieut. Dawson places the propelling agent—powder. The initiation of modern explosives has made it possible to more than treble the energies of guns as compared with the days of black powder. Secondly, their smokelessness has rendered great rapidity of fire possible, the object aimed at being practically visible at all times. Great Britain, in the Lieutenant's opinion, has not realised the utmost possibilities of advance in this direction, using cordite containing about 57 per cent. nitroglycerine instead of the nitro-cellulose powders adopted generally by the United States, Russia, France, and lately Germany. He admits that at the time of its adoption, cordite was the best explosive known, and that the experiences of other countries with nitro-cellulose powders were not for some time entirely satisfactory; but the manufacture of these powders is now much improved; they are entirely safe, stable in all climates, and under all service conditions, and at present alone "capable of producing in modern artillery the highest possible ballistics with the least possible amount of wear to the gun." The high temperature of explosion of cordite—far exceeding the melting point of steel—makes it unreasonable to expect a gun in which it is used to stand many rounds. Further, if cordite is used, "no higher velocity than, say, about 2,500 feet can be obtained for any reasonable number of rounds, whereas with nitro-cellulose powder, velocities up to and exceeding 3,000 feet can be easily obtained." The difference in military effectiveness is shown by a "dangerous-space" diagram. At a range of 2,500 yards, with an initial velocity of 1,882 foot seconds, the dangerous zone is but 162 yards in width; with a muzzle velocity of 2,160 foot seconds, it widens to 226 yards, while with a muzzle velocity of 3,000 foot seconds the very flat trajectory of the shell extends the danger zone for the attacked vessel to 465 yards in width.

A very interesting section of Lieut. Dawson's paper is devoted to the modern accurate gun sights, and one to shrapnell fuzes; a considerable portion of it is taken up with quick-firing field guns, field howitzers, mountain guns, and automatic arms, large and small. We must perforce content ourselves with passing to his concluding references to the mounting and arrangement of heavy sea-service guns, and especially the superposed turrets of the U. S. S. Kearsarge and Kentucky, which have lately excited so much discussion. In contrast with these he places an arrangement of two 12-inch guns, mounted on Vickers' system.

"This is quite a novel type of mounting, admitting of the loading of the gun at any angle of elevation as well as at any angle of training, so that during the operation of loading the gun layer is able to accurately sight the two guns, and thus immediately the one or both are loaded they can be fired. Arrangements are made that a supply of ammunition is continually being supplied through the ammunition trunk, so that the cage, which travels on the arc concentric with the trunnion of the gun, is always kept filled, and thus immediately the gun is fired the cage can be raised to the loading position, ready for a new charge.

"The system lends itself well to the general quick-loading principles applied to the heaviest types of ordnance. Two rounds per minute from each gun can easily be obtained in actual practice. Five British first-class battle-ships now building are being fitted with these mountings, making their heaviest guns really quick-firers.

"I next come to two special mountings of American type, and I will first refer to that being installed in the Alabama class for mounting their 13-inch guns. The great feature of the mounting is that only electric power is used, with the exception of the recoil arrangements, which are hydraulic in combination with heavy springs for running the gun out. The rammer is worked by hand power, and the ammunition cage lifted by electrical power. This mounting only admits of loading at a fixed angle, and is necessarily very heavy, owing to the springs required for running the gun out in combination with the heavy cradle necessary for the carrying out of this system. They do not claim to fire more than one round in two minutes from each of these guns so mounted, as against four which will be obtained from the British mounting."

Concerning the superimposed-turret arrangement of the Kearsarge and Kentucky, Lieut. Dawson says: "I am told that the arrangement has been successful from an artillery point of view, but it would strike me as being exceedingly heavy and dangerous because if one turret is put out of action it means that four of the principal guns of the ship are *hors de combat.*" It will be noticed that in the matter of gun-mountings, on their modern ships at least, the Lieutenant believes the Admiralty are to be congratulated.

The Large Gas Engine.

There are two principal ways in which the economy of production is continually being bettered; one, the improvement of the functional efficiency of existing media, the other, the utilisation of former waste. The large gas engine, as applied particularly to the use of blast-furnace gases, serves most strikingly in both capacities and thereby promises to be one of the most salient features in the advance of power engineering during the 20th century. It was ably reviewed in these pages last December by Mr. Bryan Donkin; the *Electrical Review* (London) contains some notes of a visit to Seraing, by Mr. E. Kilburn Scott, A. M. Inst. C. E., which are of additional and yet more recent interest.

The 1,000-horse-power engine, which was the largest mentioned by Mr. Donkin as having been undertaken up to the summer of 1900 is already left behind. Three Delamere-Deboutteville-Cockerill gas engines of 1,200 horse power each are on order "for a Lorraine iron works, the furnaces of which have a daily output of 300 tons of pig iron. Designs are also completed for a 2500-horse-power size, and it will probably be put in hand shortly." In fact, Mr. Scott remarks that the work he saw at the Cockerill establishment "could certainly only be effectively carried out by the very largest engine-making firms. In Germany alone three firms have taken out licenses from the Cockerill company * * * and altogether they and their licensees have about eighty engines of 500 horse power and over on order at the present time."

The gain is not confined to the utilisation of so much power formerly thrown away, nor even to the improvement indicated by the gas engines' thermal efficiency of 30 per cent., as against the 6 per cent. of ordinary steam-engine and boiler practice. There is another consideration yet. Mr. Scott quotes M. Adolphe Greiner, director-general of the Cockerill company, as saying:

"There are some works which could not have been established if the invention had not been brought into effect. I may mention the blast furnaces at Toula, in the neighbourhood of Moscow, in a situation where water is entirely absent, and a still larger works in the island of Elba under identical circumstances. The furnaces in this island, where fresh water is non-existent, will require three 600-horse-power blowing engines and three gas motors for electric plant of 200 horse power each."

The paper concludes with a particular reference to the adaptation of the gas-engine to the work of an electric station—a use to which, as Mr. Scott points out in his introduction, English engineers had declared it was quite unsuited, certainly at least in sizes larger than 40 or 50 horse power.

"Whilst Messrs. Cockerill prefer to make the single-crank engine, they also build them two-crank (as in a cross-compound engine) the alternator or dynamo being carried direct on the engine crankshaft. As it happens, the latest type of alternator, in which the poles are bolted on to the inner periphery of the fly-wheel, enables the rim of the latter to be made of great weight without any trouble, and this and the use of heavy copper bands round or through the pole faces (amortisseurs) should go a long way towards doing away with any difficulty in running alternators in parallel. Of course, for electrical work the gas is mixed, and fires at every fourth stroke, whatever the load. It is only for blowing purposes where regulation of speed is quite unimportant that the old-fashioned hit-and-miss idea is employed.

"The only trouble Messrs. Cockerill have had with the engines has been in a particular case where the blast furnace gas carried over a good deal of gritty dust. At Seraing the gas comes away comparatively clean, so that there is no trouble, but in any case when excessive dust does occur, it only means that a little more care must be taken in cleaning the gas before admitting it to the engine. For an electric power station there would be no question of dust or tar in the gas. Either the Mond process as employed at Winnington, the producer method of Mr. Thompson, Glasgow, the Duff process (Granite City Steel Company's Works, Illinois), or some similar process would be used to abstract the ammonia and other bye-products, and so the full value of the coal would be made use of instead of it being wasted in boiler furnaces. Of course, it is only when dealing with very large plants that it pays to put down the apparatus required to remove sulphate of ammonia, etc.

"When considered for the purpose of supplying power for electric transmission stations the details of the producer are almost as important as those of the engine; in fact, one of the reasons why in some cases unsatisfactory results have been attained with gas producers, has been because the attendance on a producer is such an unpleasant job that the fuel has not been fed regularly. It is quite important that the feed should be taken out of the hands of the attendants as much as possible."

The New White Star Liner Celtic.

About three years ago, Mr. E. L. Corthell plotted a very interesting curve of the progress in naval architecture for some decades back, as represented by averages and maxima of dimensions and tonnage of steam vessels. Extending it for another quarter century, it indicated that the largest steamers of that time would have a length approximating 1,000 feet, with other dimensions in proportion. The least flexible limitation, of course, was found in the insufficient depth of some of the greatest harbours of the world, but the civil engineer is constantly working parallel to the increasing demands upon the ship-builder and probably will have his task completed in good season.

Several notable steps have been taken in rapid succession during the past five years. The great cargo carrier Pennsylvania was followed by the Oceanic, still the longest vessel afloat; the speed record was captured by the Deutschland; now the leading place in gross tonnage and displacement is taken by the Celtic, like the Oceanic a White Star liner and a product of the yards of Harland & Wolff at Belfast. Until the Wilhelm der Zweite, now building, is launched at Stettin, the Celtic is entitled to honour as the largest ship afloat.

Some interesting particulars concerning the vessel are given in *Engineering* in an article from which the following paragraphs are quoted:

"The dimensions of the Celtic are: Length, 698 ft. 8 in.; breadth, 75 ft. 4½ in.; depth moulded, 49 ft.; with a total gross tonnage of 20,880, while the displacement at 36 ft. 6 in. is expected to be 37,700 tons. This, of course, includes cargo, but some idea of the immense weight involved in the vessel herself may be formed from the fact that her launching displacement was 14,259 tons upon a draught forward of 15 ft. 4 in. and aft of 17 ft. 2 in., giving an average of 16 ft. 3 in. This is the heaviest displacement of any ship launched, considerably exceeding that of the Oceanic.

"The Celtic represents a distinctly interesting type, which promises a large financial reward; for, with her speed of from 16 to 16½ knots, her coal bill will be very much less than that of many of her competitors on the Atlantic, while, at the same time, she is certainly not deficient in any of the comforts provided on the faster ships. She carries a very much larger number of passengers in the steerage, although fewer first and second than in some of the other ships, her total of first-class passengers being 347, of the second-class 160, while in the steerage she takes 2,352.

"The main propelling engines of the Celtic are of the quadruple-expansion type, balanced so as to minimise vibration. There are four cylinders, the diameters respectively being 33 in., 47½ in., 68½ in., and 98 in., the stroke being 5 ft. 3 in. The cylinders work on four cranks, the arrangement of cylinders and valves from the forward end being as follows: High pressure, with next its piston valve, then the second intermediate with its piston valve, a double-ported slide valve with a balance piston on the top for the low pressure, which comes next, then the first intermediate cylinder, with, finally, its piston valve. The arrangement of valves thus differs slightly from that in the Yarrow-Schlick-Tweedy system in respect that the high-pressure valve is between the high-pressure cylinder and the second intermediate, instead of being at the forward end; but the "centres" of the high-pressure and second intermediate cylinders are about the same as the distance apart of the other two cylinders of the engine. Each cylinder is a separate casting, supported in front on the A frame; while at the back there is a condenser incorporated into the framing of the low-pressure and first intermediate cylinders. The working parts are entirely of steel, and the connecting rods are 11 ft. 9½ in. long between centres. The diameter of the crankshaft is 19¼ in., the pins being 20 in. The tunnel shaft is 18 in. in diameter, the propeller shaft is 19½ in., and the propellers, which are three-bladed, are 20 ft. in diameter. The air, bilge, and sanitary pumps are worked by levers from the crossheads, but the centrifugal pumps are operated by separate engines. The cooling surface in each condenser is 9,000 square feet. Weir system of feed pumps is used for the main and auxiliary feed to the boiler. There are eight double-ended boilers working at a pressure of 210 lb. per square inch. The boilers are 19 ft. 6 in. by 15 ft. 9 in., the total heating surface being 41,680 square feet, and the grate area 1,014 square feet. The height of the funnels is 120 ft. above the grate area. The vessel is expected to develop a speed of 16½ knots when these engines are working at 14,000 indicated horsepower, and to most travellers on a comfortably and well appointed ship, able to withstand the heavy seas, this speed will be quite satisfactory."

Australasian Iron Resources.

In view of the general anxiety lest the world's iron resources should, within a calculable time, prove inadequate to the cumulative requirements—an anxiety set forth by Mr. J. S. Jeans in this Magazine for July, 1900, and especially in view of the menace of a large portion of the more desirable ores coming under sole control of a huge combination, the examination of British colonial iron-ore deposits has received sudden stimulation. The brilliant possibilities of Canada and Newfoundland will form the subject of an illustrated article in an early issue of The Engineering Magazine, and this will shortly be followed by an interesting review of "Iron making in Australia." Meantime a general summary of the outlook for iron manufacture in Australasia, in *The Iron and Coal Trades Review,* is worthy of comment.

So far the production has not been impressive. New South Wales occupies the largest space in the review. "There are important deposits of rich iron ore suitable for smelting purposes at Marulan, Goulburn, Bredalbane, Carcoar, Rylston, Mittagong, Wallerawang, and other districts." The last three are "roughly estimated to contain 12,944,000 tons of ores, containing 5,853,000 tons of metallic iron." The Carcoar deposits are estimated at 2,571,000 tons, consisting of "an intimate mixture of limonite and hematite." Picked samples of the hematite showed 0.113 and 0.307 per cent. of phosphorus, and it is stated that "by exercising a little more care" an ore could be supplied yielding about 50 per cent. metallic iron; but shipments have been on a guarantee of over 45 per cent., later reduced to 43 per cent., and the phosphorus in bulk samples from the quarry face have run up to 0.709 per cent. phosphorus. "There are abundant supplies of coal, which can be delivered at the pit's mouth for less than 4s. per ton, the climate is good, and there is an unlimited supply of good water, and limestone can be obtained at Portland, which is distant by railway only 17 miles." Ore shipments for three years aggregate 17,000 tons. The cost of iron making is estimated at £2. 7. 7, against £2. 12. 1 at Middlesbrough, and £1. 11. 5 at Pittsburgh. The Government has been vainly urged to establish iron works, but private concerns have proposed the erection of iron works at Port Kembla at an expenditure of half-a-million sterling.

In Victoria, an iron mine existed more than twenty years ago on the Western Moorarbool River, near the Ballarat gold fields. An offer by the Minister of Mines of a bounty of £10,000 for the first 5,000 tons of iron has never been claimed: a company seeking it discontinued operations after making 500 tons. The Federal company acquired the property and is erecting smelting works at Geelong. The ore seems to have been imperfectly examined; it is reported to run from 32 per cent. to 84 per cent. oxide of iron, the latter being at a depth of 16 to 19 feet. One lease alone is estimated to be sufficient to keep two 100-ton-per-week furnaces running for 50 years, with an estimated cost per ton of iron of £2. 10 to £3. 10 according to quality. New Zealand has the Taranaki iron sands, and the Minister of Mines has said that the Government is disposed to consider favourably a proposal to grant a bonus of £1 per ton, on the first 24,000 tons of iron or steel produced, to a company with a capital of not less than £200,000, of which £100,000 shall be spent in acquiring lands and erecting plant. It is reported that "several companies are being formed in London to manufacture steel direct from this valuable and extensive deposit."

Tasmania centers its interest, so far as iron making is concerned, in the Blythe iron mine, near Burnie, worked by an English company with a capital of £1,000,000. A narrow-gauge railway is to carry the ore "to the wharves at Burnie, there to be shipped to the other colonies and perhaps to wider markets." It is estimated that there are 40,000,000 tons of ore above water level, but the quantity produced in the first half of 1897 was 987 tons.

The South Australian Government has a standing offer of a bonus of £2,000 for the first 500 tons of pig iron produced in the colony, but it is still unclaimed.

The local demand is measured by a summary of the imports of iron, machinery, and iron manufactures into the colonies of New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, and New Zealand for three years. The aggregate was £6,840,776 in 1896, £8,713,017 in 1897, and £8,681,451 in 1898. The *Review* characterises this very fairly as "a market of first importance," but its satisfaction means the establishment of very much more than iron furnaces. Iron and coal constitute the basis of all large industries, and the Australian colonies have a fair foundation from which to start the growth of their industrial structure.

The British Iron Trade and Its Rivals.

The spectacular entrance made by the huge American trust has concentrated attention upon the iron and steel industry and called forth a deluge of comment upon the position and prospects of the British iron master. Some of the commentators are blindly confident—some deeply pessimistic—some, like Mr. Phillips in our pages this month and last, wisely analytical in pushing the examination to completeness, even if the process is painful.

The *Iron and Coal Trades Review* takes the title above for a leading editorial, which contains some suggestions not generally heard heretofore. At the outset the point is made that the public attention is so largely occupied with the iron trade not only because that trade is so very important *per se,* but also "because the same principles and conditions that affect one British industry are likely, *mutatis mutandis*, to apply to many others. * * * If Protection enables the protected country to sell dear at home in order that it may sell cheap abroad, if free trade in railways ensures cheap transport, if mechanical ingenuity and unquenchable enterprise bring about the most economical methods and processes, if powerful syndicates obtain and retain the control of price and production, if unique natural resources place the nation that owns them at an enormous advantage, then these considerations apply as much to any one industry as to any other. Hence, if the Americans are likely to vanquish us in the iron trade, one naturally asks: What about the cotton, the woollen, the leather, the paper-making, the sugar, and other important industries? The real truth is that every one of these, and many others, are more or less threatened; but we have heard an unusual number of statements and rumours about the iron trade, because the conditions affecting that trade are more directly in evidence, and because it is the basis of so many other industries in which material progress is involved."

The *Review* finds much that is encouraging in the attitude of British industrial managers—foremost that immediate determination to place themselves by every means in the forefront to which we have more than once referred in these pages.

"It is, therefore, of vital importance to note that the members of the British iron trade appear at last to be completely alive to the dangers that assail them, and to the necessity that exists for seeking to put their house in order. This process is being attempted or pursued in many different ways. Perhaps the most important of all is the new-born enterprise that has been developed in adopting up-to-date processes and plant. Most of the leading establishments and companies concerned in the iron trade are either introducing economies or seeking for them. The British Iron Trade Association has recently had under consideration the question of how far a full and exhaustive enquiry should be made into the causes and conditions affecting the success of foreign competion. Most of the leading firms in the United Kingdom have either already sent, or are now sending, experts to the United States in order to see 'how to do it,' and the lessons of American experience are now being applied at home to an extent that was never visible before. A larger amount of attention is being given to the most profitable and useful systems of commercial and technical education so as to have our rising generation better equipped for the race than hitherto. There has even been a good deal of talk as to syndicating, on American lines, the tinplate and other special branches of the iron trade. The keenest interest is being taken in the subject of extending and cheapening our supplies of raw materials, and the latest movement in this direction has been the much-talked-of development of the iron-ore fields of Dunderland, in Norway, by the Edison Ore-Milling Syndicate, whereby vast quantities of material are likely to be placed at the disposal of the British iron industry. All this, and much more, makes for improvement, and encourages the hope that the British iron industry may be able, after all, to show a good fight." We should go most of the way with the editor of the *Review* in his conclusion that these things are encouraging for the British iron industry, but we should have to leave him just this side of the Dunderland project. We do not see much encouragement for the British iron trade in that. The *Review* concludes, however, with the rather surprising statement that the British iron trade is "handicapped, and, probably, may continue to be so by two fundamental conditions:

The first, the limitations placed on the command of capital within the iron trade itself; and the second the natural disinclination of capitalists not in the trade to embark in a business that is so notoriously uncertain and precarious. We use the words 'natural disinclination' because the iron trade has never been regarded as one of the safest investments, and, because, in face of the much-talked-of competition of other countries, and the very palpable demonstrations of its success, the future of the British iron trade appears to be more uncertain than ever." The British iron industry has been accused of apathy, overconfidence, overconservatism, dangerous indifference to competition, inability to get out or even see out of a rut, superannuation, and many other failings; but the imputation of poverty seems new. The *Review* however fortifies the statement with corroborative evidence that capital has been slow to engage in the iron industry:

"It is a remarkable fact that no new iron or steel works of any importance have been constructed in this country for a long period. We believe that the last new British ironworks were built so far back as 1890, or practically eleven years ago. In the interval, Germany and the United States have constructed many new establishments, and made important additions to many more. This naturally gives to those countries the command of more efficient and economical plants than we possess in Great Britain. Every practical ironmaster and steel manufacturer knows that a completely up-to-date plant, erected in a suitable locality, under sound and honest conditions, would be likely to make easier and larger profits than most of the older plants with which it would have to compete. A large number of those older plants, to begin with, are greatly overcapitalised, and in a good many cases their inflated capital represents very little more than scrap values. All this should be altered with a plant on the most modern conditions."

Perhaps if English iron masters had been less content with what Mr. Phillips calls "antiquated ding-dong methods," the business would not have fallen into disrepute as "uncertain and precarious" in its profits and capital would have been as ready to embark as it is in the United States and Germany. At all events the way out is by modernising the iron and steel making plant; modernising means investment of capital, and we venture to predict that the capital will be forthcoming.

Combined Trolley and Conduit Tramway Systems.

In a very practical paper read before the Institution of Mechanical Engineers, Mr. A. N. Connett gives some of the results of his wide experience in America and Europe in the construction of conduit roads, and speaks particularly of combined trolley and conduit systems.

"In many cities where the overhead trolley is admitted on surface tramways, there often exists a street or a central zone where it is expressly prohibited." Other cities forbid the trolley to enter their boundaries at all, and when suburban trolley lines reach the city limits a change of cars is necessary, or else the cars must be equipped so that they can use another system of traction. There is no one plan which is best under all conditions, but that which is generally adopted is the combined trolley and conduit system.

"The problem of adapting the plough and track mechanism to change from the overhead line to the conduit system, or vice versa, has been satisfactorily and carefully worked out on several different general principles. In America, where the conduit has been generally adopted in the cities of New York and Washington, the problem of a mixed line has received very little consideration, but on the continent of Europe there are a number of systems of this kind, and they are all worthy of attention, the problem having received careful study in each case. This, in the author's opinion, is only one instance in several, where European tramways now offer a much more fruitful field for study than American, especially so to the engineer called upon to install a system in Europe under European conditions and requirements."

In regard to the question whether the conduit shall be of side-slot of centre-slot construction, the author believes that "if the engineer has his choice he will undoubtedly adopt the latter type. But on the Continent there is an objection on the part of the municipal authorities in some of the cities to the centre-slot. The advantages of the side-slot conduit are that the additional band of iron in the street required by the centre-slot rails is avoided, and that the maintenance of the paving is thereby simplified, every joint of a rail with the paving being a sourse of weakness in the life of the latter.

"The principal trouble with the side-slot conduit is that connected with the switch. In the case of the centre-slot a comparatively light movable tongue can be hung or pivoted to the fixed tongue, its use being simply to guide the plough. With the side-slot the tongue is much stiffer and heavier, because it must also guide the wheels of the car and support them in one position; that is, the entire tongue is movable, and its upper surface from point to heel must be level with the wheel rail. To avoid troubles at the switch the author suggests that before the switches are reached, the side-slots should be deflected to a central position. There are no mechanical or electrical difficulties in this case, as demonstrated by the results of actual operation in Paris.

"The first decision to be made for a line partly conduit and partly overhead is whether the plough shall be carried continually on the car, or removed and replaced at each junction point of the two systems. The latter is the simpler method. A roomy manhole containing a man to do this work is all that is needed; but it requires no argument to prove that this is undesirable and expensive. One is then impelled to a method whereby the plough is always carried on the car and can be raised or lowered at junction points. The most natural and neatest solution of this problem is to raise the plough through the slot with no special arrangement in the latter. This has been successfully done in Berlin and Brussels. In the former city the plough is equipped with a wheel at its lower extremity, which runs up an inclined plane; and the contact-shoes working on horizontal axes pass through the slot by being depressed to a vertical position. The wheel then runs in the groove of the wheel rail, and is raised clear of the track by the turn on a crank given by the motor-man. At the same time, the conductor loosens the bow sliding trolley, and the operation is complete. The entire change can be made without stopping the car. In Brussels the plough is raised by the motor-man, the inclined-plane feature being discarded. A wheel-trolley is used, so that a stop is necessary to catch the trolley-wire.

"In these two cities the ploughs are not mounted on slides permitting a lateral motion across the car, and the two slots of a double-track road being located on the interior rails, it is necessary to carry two ploughs with a raising and lowering mechanism for each. If the requirements of the road demand cross-over switches from one track to another, a third conduit is necessary for a short distance at such points."

But by the use of a system of slides and plough-construction devised by the author, the plough can be shifted from one side of the car to the other and can be lifted out of the slot when necessary. With this construction and with the deviation of the side-slot to the centre before switches, the need of two ploughs and a third conduit is entirely obviated. The best form of contact shoe does not permit the plough to be lifted through the narrow slot, and a movable trap has to be employed at junction points. On some French roads where this system is used, a man opens the trap, raises or lowers the plough and closes the trap while the conductor lowers the trolley from or raises it to the trolley-wire. The whole operation takes on the average ten seconds, and as these junction points generally coincide with stopping places to load or discharge passengers, practically no time is lost.

The author gives some interesting figures concerning the cost of conduit roads, based on actual experience, which cannot be given here for lack of space, and for which the reader is referred to the full text of the original article.

REVIEW OF THE CONTINENTAL PRESS

The Zeppelin Air-Ship.

Although there have been many general accounts of the flights of Count Zeppelin's air-ship over the Lake of Constance last summer, they were nearly all deficient in the details which are of such great importance in forming a correct judgment of the experiments, but in a recent issue of the *Zeitschrift des Oesterreichischen Ingenieur- und Architekten-Vereines,* Captain Hermann Hoernes gives a very complete description of this remarkable balloon and its three trial trips.

As is generally known, this air-ship is in the shape of a long cylinder, with ogival ends. To be more precise, the cross-section of the central body is a polygon of twenty-four sides. The aluminum framework is 128 meters (420 feet) long, 11.3 meters (37 feet) in internal, and 11.66 meters (38.25 feet) in external diameter. The capacity of the balloon is 11,300 cubic meters (400,000 cubic feet) and the total weight about 10,200 kilograms (22,500 pounds). This shows it to be the largest balloon that has ever flown. The framework is built up on sixteen 24-sided rings, formed of lattice-work 18 centimeters deep. These rings are stiffened by tie rods running directly across, and also by spokes fastened tangentially to a one-meter central ring. The longitudinal members which connect the rings are likewise latticed, and are stiffened every 80 centimeters by aluminum straps. Beyond the end rings, the longitudinal members gradually converge to the bow and stern. The aluminum framework is covered, inside and out, by a network of thin ramie cord, with a mesh of 20 to 25 centimeters.

There are seventeen compartments formed by the rings, and in each is an independent balloon, which was filled with hydrogen gas before the trips. The compartments are each 8 meters in length, except those directly above the two cars, which are 4 meters long.

The balloon envelopes are made airtight with a preparation called ballonin, invented by the Finnish æronaut Lievendahl. Each balloon has an automatic safety-valve, and five of them are provided with manœuvering valves, which are operated from the cars. The outer covering of the framework is not airtight. It serves merely to give the ship a smooth surface, offering little resistance to the air, and to protect the inner balloons from atmospheric influences. The under side of this covering is therefore of very light silk, while the upper side is of waterproof material.

The two pontoon-shaped aluminum cars are 6 to 7 meters long, 1.8 meters wide and 1 meter deep, and, when empty, weigh 220 kilograms. They have double bottoms, holding water ballast. They are fastened 2 to 3 meters underneath the body of the ship by aluminum tubes, at a distance of 34 meters from the bow and stern respectively, and between them stretches a latticed stiffening girder 60 meters long and 1 meter deep.

In each car is a Daimler benzine motor, with electric ignition, which develops 16 horse power at 700 revolutions per minute. The weight of this motor, with flywheel and cooling-water pipes, is 450 kilograms, or about 28 kilograms (62 pounds) per horse power. The consumption of benzine is about 0.375 kilograms (0.83 pounds) per horse-power hour, and as the capacity of the tanks is 60 kilograms, enough fuel is carried for a flight of ten hours. These motors were built more than two years ago, and although they are light compared with those used on former air-ships, their makers have since attained much better results.

Each motor, through gearing and rods with universal joints, drives two aluminum screw propellers, placed high up on the balloon's side, with their centers about 1.5 meters therefrom.

The propellers are comparatively very small, only 1.15 and 1.25 meters in diameter; they weigh 15 kilograms apiece, are four-bladed and make 1,100 revolutions per minute. Water ballast is carried in two bags, holding 200 kilograms apiece, placed inside the framework, and arranged so that 20 kilograms can be emptied at a time. These bags are situated near the bow and stern respectively, and there are twelve more, holding 50 kilograms apiece, placed near the middle of the ship. Furthermore, there are four bags, each holding 40 kilograms of wet sand, fastened to the stiffening truss.

But the air-ship can be raised or lowered otherwise than by dropping ballast or letting out gas. When the balloon's axis is inclined to the vertical, and the propellers are set in motion, the ship is driven to a greater or lesser elevation, depending upon the direction of the axis. In order to give the balloon this inclination, there is a cigar-shaped block of lead, weighing 150 kilograms, attached to a small carrier running on the stiffening girder. This carrier is moved back and forth by thin wire ropes leading to the cars.

The steering apparatus underwent many transformations in the course of the experiments, but at the time of the last ascension there were three rudders, a horizontal one forward, to direct the ship up- or downward, a small vertical one forward and a large vertical one aft, all underneath the body of the balloon.

The air-ship was built in a floating boat house, so that it could be launched in the direction of the wind. It rested on a float, which was drawn out of the boat house whenever a trip was undertaken.

The first ascension was made on July 2, in the early evening. Count Zeppelin and two assistants were in the forward car, while the after car carried two men. As the air-ship began to rise, some of the after lines were held too long, in consequence of which the ship, instead of ascending in a horizontal position, had its bow pointed upwards. The movable weight was therefore hastily pulled forward, which made the bow sink too low, and when Count Zeppelin tried to bring the weight back to its central position, some of the apparatus broke and the weight would not move. In the meantime, the ship had ascended to a height of 300 meters above the lake, and after making some distance against a very light breeze, the steering lines became jammed, and the ship was henceforth compelled to run before the wind. On this first trip there was no stiffening truss, and the framework of the balloon showed signs of bending.

So after a flight of about seventeen minutes' duration, the ship descended, but in settling down upon the water, it ran into a stake used to mark the channel, which had been observed in the twilight, and sustained some damage.

This first trip showed that various changes were necessary, and in carrying out these alterations and in making repairs, over three months were consumed.

The second ascent was made on October 17, in the late afternoon, and a successful flight of about an hour was brought to a close by the escape of the gas in the third balloon, which caused the forward end to sink more than could be counterbalanced by the movable weight. The ship, therefore, drove rather rapidly downward to the water, but was not seriously hurt by the shock.

There were some slight damages, which it took a few days to repair, and the third—and, so far, the last—flight was made on October 21, during a dead calm. This trip, although it lasted but twenty-three minutes, was of particular interest, because the ship described a figure-of-eight course and descended very near the starting point. Although it settled down on the water gently, it sustained, as usual, some strains and slight damages, and as the autumn was so far advanced, no more trips were undertaken that season.

Captain Hoernes criticises several features of the Zeppelin air-ship, among which may be mentioned the low power, only 32 horse power, for such a large vessel. Even this power does not appear to be used to the best advantage, on account of the small diameter of the propellers and their large number of blades. The ship with its present power would be unable to make any headway against even moderate winds, which, of course, limits its practical use.

The rigid frame, with its outer covering of silk and waterproof stuff, makes it very hard to land without sustaining some damage, and in a high wind the balloon would surely be injured.

The rapid ascent and descent of the ship can be accomplished only by dropping ballast or by letting gas escape, and for a flight of long duration, this would hardly be practicable.

Another objection to the Zeppelin ship is its lack of stability, owing to the height of its center of gravity.

In spite, however, of all these difficulties in the way of the extended use of this airship, the experiments made have been very instructive and of real service to the science of aeronautics, and they may help to point the way to a successful solution of the problem of aerial navigation.

The Economy of Electric Traction in France.

While the displacement of animal traction by electric on street railways is generally an unmixed benefit to the public at large, there may sometimes be a question whether, all things considered, the owners of the road derive a net profit from the change. This question is discussed in a recent issue of *Le Génie Civil,* where the problem is stated in the following way:

Having given a tramway system with animal traction:

1. What will be the cost of electrical equipment?
2. Will the increase in net receipts resulting from the change be sufficient to augment the rate of interest on the total capital invested?

By "total capital" is meant both the original capital invested in the horse railway and the cost of the electrical equipment.

In considering this question of new equipment, we may assume that the tramway systems have no competitors within their respective districts and are therefore not obliged to improve their operating methods in order to hold their old traffic. In this respect they differ from a factory or machine works, which is compelled to better its equipment and modernize its methods, or else be forced to the wall by wide-awake rivals. With the tramways we are discussing, the improvement was not a matter of life and death, but could be considered simply with reference to its effect upon operating expenses and receipts.

The data for the discussion are taken from the experiences of six French tramway systems in the cities of Rouen, Le Havre, Versailles, Nancy, Amiens and Roubaix-Tourcoing, which have recently changed over from animal to electric traction. The results are analyzed in a number of tables, which show very clearly the effects of the change.

The most characteristic feature of the substitution of electric traction for animal is the increase in the number of passengers carried, which shows very clearly that the new system enjoys the favor of the travelling public. This increase varied from 209 per cent. in Rouen to 37 per cent. at Roubaix-Tourcoing.

When the change was made, the accompanying increase in length of track varied from 91 per cent. at Havre, to 7 per cent. at Roubaix-Tourcoing, so that the number of passengers carried per kilometer of track increased from 143 per cent. in Rouen to 21 per cent. at Versailles. This increase per kilometer is generally considerably less than the total increase, which is accounted for by the fact that the new portions of the roads are in outlying districts where the traffic is naturally not so heavy. So in order to get an idea of the increase in traffic on the old portions of the roads, we may take a mean between the last two sets of figures. The increase in the number of trips per inhabitant varied from 197 per cent. at Rouen to 28 per cent. at Roubaix-Tourcoing.

In order to provide for the increased traffic, and also to incite it, cars are run much oftener. This frequency of traffic is one of the most telling causes for the popularity of the electric roads, but it cannot be increased indefinitely without lowering the net profits. To find the most profitable frequency is a complicated problem, whose solution varies from case to case and depends entirely upon experience. The opinion of M. de Marchena on this subject may be quoted: When a line is overloaded with passengers, the receipts increase in proportion to the number of cars in service, but after reaching a certain point, which might be called the "saturation point," the increase in receipts grows less than the increased frequency of service. Nevertheless, when the operating expenses are small, it is profitable for the road to pass this point and increase the service as long as the extra receipts exceed the extra expenses. The more economical in operation a system is, the farther is it possible to go in this direction. With electric traction in particular, a railway is not being worked to the best advantage until the activity of circulation is such that each car carries only a few passengers. This may appear paradoxical at the first glance, but it is nevertheless a fact. In this way, the interests of the public and of the railway company are intimately connected, and the latter seeks to realize the maximum profit by lowering the fares and increasing the service as far as the resulting increase in traffic will warrant the greater expense.

The increase in the number of car-kilometers varied from 208 per cent. at Versailles to 57 per cent. at Nancy.

The increase in gross receipts varied from 158 per cent. at Versailles to 49 per cent. at Nancy. These figures, owing to the lower fares, are not the same as those for the increase in number of passengers. The receipts per car-kilometer show a *decrease,* varying from 24 per cent. at Rouen to nothing at Amiens. This decrease may be due to either of two causes: the smaller number of passengers per car-kilometer, or the lower average fare. These two causes tend to counterbalance each other, and the rates are so adjusted that the resultant effect is kept as constant as possible.

It is found, on the whole, that there is a notable increase in the gross receipts, owing chiefly to the increase in frequency of service, in speed and in comfort.

Turning now to the other side of the account, we find that the decrease in operating expense per car-kilometer varied from 53 per cent. at Rouen to 15 per cent. at Havre. But owing to the much greater number of car-kilometers with electric traction, the total operating expenses increased. This increase varied from 90 per cent. at Versailles to 36 per cent. at Rouen, but in every case it was less than the increase in gross receipts, so that there was a gain in the net receipts, which varied from 1035 per cent. at Rouen to 136 per cent. at Nancy. At Versailles the result was even more remarkable, for, whereas formerly there was an annual deficit of 13,000 francs, the net receipts are now 76,000 francs.

On comparing the net receipts with the capital investment, it is found that under the old system of animal traction the ratio varied from 9.77 per cent. at Havre to —0.68 per cent. at Versailles, a deficit occurring at the latter place, as already mentioned. When the *gain* in net receipts under electric traction is compared with the cost of the *new* equipment, the ratios vary from 9.71 per cent. at Havre to 4.16 per cent. at Amiens. The final table shows the ratios of the total net receipts under the new order to the total capital investment (including the original investment in the horse railway and the cost of the electrical equipment), and the figures run from 9.47 per cent at Havre to 2.11 per cent. at Versailles.

Notwithstanding the much larger investments, there is here shown an increase in the rate of dividends in every case except at Havre and at Amiens. At Havre, which shows the greatest profits under both systems, the difference is but small, and at Amiens the figures for the horse railway were taken in an exceptionally favorable year, while those for electric traction were taken in the first year of operation, before the system had a firm footing, so that here the true showing would be more favorable to electric traction than is indicated in the table.

The final *increase* in the rate of profits is 0.52 per cent. at Nancy and Roubaix-Tourcoing, 2.79 per cent. at Versailles, and 4.74 per cent. at Rouen. Except at Rouen, where the profits increased from 1.61 per cent. to 6.31 per cent. and at Versailles, where a deficit of 0.68 per cent. was converted into a profit of 2.11 per cent., these results are not startling, and show that in France, at least, electric tramways do not offer very extraordinary inducements to investors of capital, however much they may benefit the public.

Fly Wheels for Internal-Combustion Motors.

One of the portions of engine design which has received much attention from writers of high authority is that which relates to the design and proportion of fly-wheels, and from the older method of rule of thumb there has grown a number of empirical rules. All these, however, relate to the double-acting steam engine, in which there is an impulse of greater or less duration and magnitude in every stroke. In the case of gas engines and other motors, operating on the Beau de Rochas cycle, however, there is but one power impulse in every four strokes, in addition to which there is a compression stroke in every four which must be effected by the energy stored in the fly wheel. For these reasons the conditions affecting the weight of the wheel for a required steadiness of revolution are altogether different from those which obtain in the steam engine.

This whole subject of the proportions of fly wheels for internal combustion motors is discussed in a paper by Herr Hugo Güldner, in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure* in an exhaustive manner, and while a full examination of his treatment can only be made by reference to the original papers, the method and some of the results may be briefly noted.

The very variable character of the quantities involved render it almost impossible to apply any analytical treatment, and the same reasons make the graphical examination particularly applicable, especially as indicator diagrams supply the data for nearly every type of engine which may come under examination. By taking the pressures at every point of the stroke for one or more complete cycles, and converting them into the equivalent tangential impulses and retardations the irregularities to be equalized by the fly wheel are not only made visible but also rendered suitable for measurement and computation.

Herr Güldner has worked out such tangential diagrams for a number of internal combustion motors, including the Hornsby-Akroyd, Hille, Körtung, Westinghouse, Bànki and Diesel; the latter including diagrams from the air compression pump which forms an essential part of the machine and is driven by it. These diagrams are then made the subject of computations, the areas being measured by the planimeter, and the relation between the impulses and the resistance expressed by equations for practical use in computations.

For the usual four-cycle motors Herr Güldner gives the following formula, which he states gives results within 2 per cent. of those made by plotting the actual diagrams and measuring the quantities.

$$G = \frac{(0.75 + r)\ 8200\ N}{d\ R^2\ n^3}$$

In this formula G is the weight of the rim in metric tons of 1,000 kilogrammes (2,208 pounds), r is the value of the mean compression pressure divided by the mean impelling pressure, d is the percentage of variation of speed, that is, the difference between the maximum speed and the minimum speed, divided by the normal speed, N the indicated horse power of the motor, R the radius of the fly wheel, and n the number of revolutions.

The following values of r are given as corresponding to good practice for the various classes of motors:

Gas engines with illuminating gas	r 0.25 to 0.35
Gas engines with producer gas	r 0.40 to 0.50
Petroleum engines	r 0.30 to 0.40
Benzine motors	r 0.10 to 0.20
Diesel petroleum motor	r 0.48 to 0.52

Herr Güldner gives numerous tangential diagrams for motors with more than one cylinder and for various successions of power strokes, and for such it is best to construct to corresponding diagrams in each case and deduce the proper weight of fly wheel accordingly. This method is really to be preferred in any case, as it enables the conditions to be seen at a glance. For new engines of which indicator diagrams have not been taken, the theoretical diagrams may be constructed, or actual diagrams taken from existing engines of similar type may be used.

The paper contains much valuable information concerning the equalisation of irregular impulses by means of rotating masses, and similar methods are applicable to other than internal-combustion motors.

The Rasch Arc Lamp.

COMMENT was made in these columns last month upon the form of arc lamp devised by Herr Ewald Rasch, in which the arc is established between terminals of refractory materials which have been rendered conductors by preliminary heating. As might have been expected, this is followed by a communication from Dr. Nernst in the Elektrotechnische Zeitschrift, criticising the estimates of illuminating efficiency made by Rasch, and also showing that the new light was partly at least anticipated by himself.

Dr. Nernst very properly remarks that

comparisons can be made only upon the spherical candle-power, and when the figures for the continuous current and alternating current arc lamps, as well as the Nernst incandescent lamp are reduced to spherical candle-power the showing is much better for them. Taking some tests by Wedding, it appears that for a 9-ampere arc lamp the mean effect was 1.38 watts per candle for the space below the horizontal. This was for the alternating current, and as the distribution of light in that case is the same above and below the horizontal, this may be taken as the spherical candle power. Taking a continuous-current arc lamp, the energy required was about 0.5 watts per candle below the horizontal, and neglecting the space above the horizontal, this should be doubled to give the spherical candle-power. In actual practice, taking into account the necessary resistances, Wedding considers that average values are 1.9 watts per candle for alternating lamps, and 1.37 watts for continuous-current lamps.

Taking the electrolytic incandescent lamp bearing his own name Dr. Nernst shows that the mean spherical illumination is produced by an expenditure of 1.73 watts per candle, or allowing for the necessary resistance, it may be placed at 1.9 watts, or about the same as that of the alternating-current arc lamp.

In the course of his experiments upon his incandescent lamp Dr. Nernst also examined the action of arcs between electrolytic terminals, such arcs being naturally formed when at any time the filament of his incandescent lamp parted. According to his observations of such arcs, the very high temperatures produced a material vaporisation of the electrodes, and these latter were far from being permanent. It is interesting to learn that the consumption of the terminals was in the opposite direction to that of the carbon arc lamp, the negative pole being wasted away more rapidly than the positive, a circumstance which may throw light upon the theory of the arc.

For the same materials used in the Nernst incandescent lamp it appears that the life of the electrodes would be very short, but as the exact composition of the electrodes used by Herr Rasch has not yet been made public, it is too soon to form positive conclusion as to this important point.

There is no doubt that the points raised by Dr. Nernst are of much weight, based as they are upon his own experience in similar lines of reseach. At the same time the new light apears to be of so much promise that it is to be hoped that his objections are largely due to insufficient information. At the same time his caution as to the necessity of using the same standard of illumination when comparing different lamps is very well taken, and before any opinion can be formed as to the real illuminating value of the various kinds of arcs, it must be made sure that the data have all been reduced to the same standard.

It seems as if the electric lamp, so long stationary, has again become an object of attention on the part of investigators and inventors, and with the attention now being given to both arc and incandescent lamps, there is every probability that marked practical improvements will result.

State Railways in Prussia.

In the course of a recent debate in the Prussian House of Deputies over a railway accident at Offenbach, there were brought out many facts concerning the state railway system of Prussia, which were of so much technical and economic interest that the *Zeitschrift des Vereines deutscher Ingenieure* gives a very full report of the discussion, and adds thereto the opinions of four outside professional railroad men of great ability and experience who speak without any official bias.

One of the deputies, Herr Macco, emphasised the tremendous influence on the public welfare which is exercised by the state railways, and said, very properly, that they should take the lead in progress and in the introduction of modern improvements. He declared that the members of the technical staff were fully competent to carry out reforms, but that they were bound and fettered by a rigid system, and he went on to instance some of the particulars in which the Prussian state railways are behindhand.

This railway system is only now proceeding to substitute rails weighing 42 kilograms per meter (84 pounds per yard) for those of 32 kilograms (64 pounds), whereas in other countries the best railway practice employs 100-pound rails.

The road bed is good when new, but there are not large enough appropriations for proper maintenance of the permanent way, which in consequence inevitably soon falls out of repair.

Some improvements in passenger cars have recently been made, but they were not due to the initiative of the Prussian officials, being largely copied from American practice, and were generally carried out only after continued agitation of the subject by private persons.

It appeared further, from the remarks of Herr Macco and the subsequent reply of the Minister of Public Works, Herr von Thielen, that while the freight car system is a very uniform one, it is lacking in many particulars. The cars are of comparatively small size, even the latest ones having a capacity of only 15 tons. The dead weight of the car is 50 to 60 per cent. of the total weight, as against 25 per cent. in some other countries. While it is admitted that the shippers themselves may not be quite ready for radical changes, it is claimed that the railway authorities should look a little ahead and prepare the way. The facilities for rapid unloading are poor, and the freight cars have neither air-brakes nor automatic couplers.

It is generally agreed that the locomotives are very efficient, from a thermodynamic standpoint, and that for ordinary traffic and small trains they are satisfactory.

But while the efficiency of the locomotives is good, and their construction strong and durable, they are lacking in capacity. They are not powerful enough to haul heavy trains at high speed, and it frequently happens that express trains have to be supplied with two engines. One reason for the comparative lightness of the Prussian locomotives is the state of the permanent way, which limits the allowable weight per axle to 16 tons, whereas in America the axle loads go as high as 21 or 22 tons.

This lack of power in locomotives limits the economy of transportation, and in spite of the great cost which must be incurred in strengthening the permanent way, it is felt that the Prussian railway authorities will be compelled to follow the example set in other countries and make the improvements.

One critic alleges that the Prussian locomotives are built too well, so that they become antiquated before they wear out, and are retained in service longer than good practice warrants. This inherent inertia is one of the weakest points of a system of state ownership of public utilities, and the general arguments against such a system are well put by one of the technical men who was interviewed:

For every important problem which demands solution, it is not possible under a system of government ownership, as it would be in a private enterprise, to pick out a specially able technical man and give him the necessary far-reaching authority to settle the difficulty. The organisation does not permit the individual even to make proper use of his abilities. Not one head and one will governs, as must be the case when important problems are to be solved satisfactorily, but many. On account of his many routine duties of management, and the frequent shifting from place to place, the engineer has neither time nor opportunity for technical work. The authority of the higher officials over their subordinates is not great enough to force the introduction of useful and practicable innovations against the opposition of the latter.

Under the present Prussian system, the technical men, particularly the mechanical engineers, occupy an insignificant position, so that technical improvements which necessitate preliminary studies, costing money, and a certain freedom of action, are made practically impossible.

Any government railway system under such conditions will be obliged to imitate more or less slowly the improvements introduced on private lines in other countries, and cannot hope to take the initiative itself until it provides for an efficient technical staff entirely free from the hampering bonds of a bureaucratic administration.

Accumulator Cars on Standard Railways.

A BRIEF reference has already been made in these columns to some experiments with accumulator cars on sections of the Bavarian Palatinate railway system, but since then Herr Gayer, under whose direction the operations were conducted, has delivered an address before the "Verein für Eisenbahnkunde," which has been published in *Glasers*

Annalen, and from which some of the details are abstracted.

These cars are run on sections where there is not enough local traffic to justify the operation of many way trains with steam locomotives, and yet where a frequent service is very desirable. They also act as feeders for through express trains by picking up passengers at way stations and carrying them to the express stopping places.

That the accumulator cars have found favour with the public is shown by the fact that in 1900 the few that were then in operation covered 96,912 kilometers on main lines and carried 303,222 passengers.

The experiments on the main line were begun in 1896, and the only serious difficulties met with were in the accumulator plates, which was not to be wondered at, as there had previously been no practical experience with accumulator traction on such a heavy scale. These difficulties were successfully overcome, and the accumulator company was finally able to furnish batteries which worked satisfactorily in every respect. When this stage was reached, new cars were provided and were put in operation early in 1900. Two of these are four-axle cars, with a seating capacity of 112, and two are three-axle, carrying 68 passengers. The four-axle cars have a center aisle and are 17.86 meters long and 3 meters wide. These cars have three compartments, the middle one being third-class, while the end ones can be used as second- or third-class, as desired. On some of the trips an ordinary third-class trailer is carried, which adds fifty to the seating capacity. The seats are placed across the car, back to back, and in order to provide for rapid emptying of the car, there are six doors on either side of the long central compartment, besides the doors for the end compartments. At the extreme ends of the car are the compartments for the motorman, which are provided with speed indicators, besides the usual controllers, meters and brakes. The cars are heated and lighted with current from the accumulator cells, which are placed in wooden boxes under about two-thirds of the seats. These boxes are carefully lined with isolacite and linoleum, have an outlet at the bottom for any acid which may slop over, and are ventilated to allow the escape of fumes. There are six cells in each box, each cell containing seven positive and eight negative plates, 30 centimeters square. The connections are not soldered, but screwed, so that the individual cell can be easily removed, and as the seats forming the tops of the boxes turn back, all parts of the battery are easily accessible at all times for inspection and repair.

Each car carries 156 cells, with a guaranteed capacity of 225 ampere-hours, and as only about 120 ampere-hours, on the average, are consumed on the longest run, there is a reserve of about 90 per cent. This large reserve was provided in order to avoid discharging the batteries too far and also to allow for any depreciation.

The batteries are charged at the end of every trip for a time varying from 30 to 75 minutes, with a current of 150 to 200 amperes. For each car there are two four-pole motors, which drive both axles of the truck through gearing with a ratio of 1 to 3. The cars run at an average speed of about 40 kilometers per hour, and cover about 150 kilometers a day.

The empty cars weigh about 26,000 kilograms, the batteries about 15,000 kilograms and the motors 4,000 kilograms, a total of about 45,000 kilograms, or nearly 45 long tons. When carrying 106 passengers, a motorman and a conductor, the total weight is about 53,000 kilograms, or about 6,600 kilograms load per wheel. Even allowing for the large number of passengers carried, the dead weights of these cars compare very favourably with those of ordinary trains.

The cost of a car such as has been described, with its electrical equipment, is given at about 55,000 marks. Allowing for depreciation of the battery and assuming its electrical efficiency to be 65 per cent., and also assuming that current costs 10 pfennigs (2.4 cents) per kilowatt-hour, it is found that the total operating expense, taking interest, depreciation and everything else into consideration, is 27.52 pfennigs per car-kilometer (10.5 cents per car-mile), or 0.26 pfennigs per seat-kilometer (0.1 cent per seat-mile. These figures are lower than those for steam traction under similar conditions, and there are so many other advantages connected with accumulator traction on the lines about Ludwigshafen and its neighbouring cities, that it has gained a permanent position.

REVIEW OF THE AMERICAN PRESS

Volcanic Disturbances in Nicaragua.

WITH the closing of the Fifty-sixth Congress, the Isthmian Canal has temporarily passed into a less prominent place in the public view. It is possible, and very much to be hoped, that these comparative lulls in violent partisan advocacy of a particular route will tend to advance general education in the real merits of the question, and so aid in permitting a final solution based on sound engineering and commercial principles.

The *Railroad Gazette,* which has always ably championed the cause of full enlightenment before action, publishes some very striking excerpts from a series of lectures by M. Bunau-Varilla, a distinguished French engineer who has recently travelled in America and lectured on the Isthmian-Canal projects before engineering and commercial bodies. The lectures have been published independently in pamphlet form, and with their graphic charts afford the most striking demonstration of comparative length, curvature, magnitude, cost, and conditions affecting stabilty that we have yet seen. The extracts in the *Gazette* relate to the probability of volcanic disturbances along the two routes. M. Bunau-Varilla was formerly engineer-in-chief of the Panama Canal, is a director of the Congo Railroad, and president of Spanish coal and rail enterprises. He is therefore fitted, as the *Gazette* points out, to speak with special knowledge and with the responsibilty of one accustomed to great enterprises.

The danger from seismic disturbances during and after construction, he points out, was not discussed by the United States Isthmian Canal Commision in the preliminary report, and yet it is one of the most serious considerations in the problem.

"It is entirely false to compare the equilibrium of dams and locks with that of a high tower of a church. A wall or tower, even fissured, can stand after an earthquake. A longitudinal fissure in a dam, which will not alter its equilibrium as a wall without pressure of water, would mean its immediate overthrow when the water pressure is exerting its force upon the surface of the inside fissure.

"Outside of the danger of seeing ruined the dam or the locks by a great seismic commotion, one must not forget that there is great probability of seeing formed in the sea of Nicaragua, which is 100 miles long and 45 miles wide, one of those terrible tidal waves which were so destructive in Lisbon (earthquake of 1752), and Krakatoa, 1883, the latter being 100 ft. high and the former 40, causing unlimited disaster.

"It must be borne in mind that these menaces would mean, if realized, not only the destruction of that costly canal, but the ruin of the interests of both sides of America, which will have been developed by the great waterway."

The comparative exposure to risk from volcanic or earthquake disaster should therefore be examined most carefully in making a decision between the Panama and Nicaragua routes. "In Panama, there is within a distance of 180 miles from the canal no volcano, even extinct." The isthmus there has not been modified since the quaternary period. Nicaragua, on the contrary, has always been the site of seismic convulsions. The lake was formerly a gulf in the Pacific; the name is "associated with the most terrible volcanic explosion ever recorded in history before the Krakatoa explosion in Sound's Islands."

"The explosion of the volcano Coseguina in 1835 lasted 44 hours, the noise was heard at a distance of 1,000 miles, the ashes were brought 1,400 sea miles by the winds; * * * during these 44 hours the volcano ejected every six minutes a volume of stone and ashes equal to the total volume of the prism of the Nicaragua Canal, as it was calculated by the Nicaragua Canal Commision, and which will necessitate eight years of excavation.

"In the very center of Lake Nicaragua is a volcano in constant activity, the Omotepe, whose last great eruption occurred in 1883.

"Between the two above named volcanoes we find a series of volcanoes in recent or continuous activity, the Hell of Masaya, on the shore of Lake Nicaragua, the celebrated Momotombo, on the shore of Lake Managua, the volcano of the Pilas, which was born in 1850, the Santa Clara, the Zelica, the Nindiri, being the best known of them."

According to the appendix to the Nicaragua Canal Commision's report: "In the northwestern part of Nicaragua, slight earthquakes are frequent. Scarcely a month passes without one or more being noticed. The center of these disturbances is always near the line of the Nicaragua volcanoes; the line of volcanoes begins with Madeira (near the Omotepe), at the southern end, in Lake Nicaragua, and terminates at Coseguina, at the northern end, near the gulf of Fonseca."

M. Bunau-Varilla enforces his observations by citing "two most important facts * * * recently established by M. Bertrand, geologist and member of the Institute of France:

"1. The Lake Nicaragua is one of the three lines of least resistance in Central America, which are a site of election for great seismic disturbances. It is the line of depression between the Costa Rican volcanoes and the Nicaraguan, and plays the same part as the other two; the bay of Fonseca, which is a volcanic lake characterizing the depression between the Nicaraguan and Salvadorian volcanoes, and the Lake Pacayan, characterizing the depression between the Salvadorian and Guatemalan volcanoes. These two last lines of least resistance have been the site of the most terrible convulsions owed to the Coseguina for the former and to the Fuego (Fire) for the latter.

"2. The underground fire is going south, and increasing in Nicaragua. From the figures given by M. Bertrand I calculated that before the nineteenth century, out of all the great explosions or earthquakes recorded. 45 per cent. belonged to Guatemala, 35 per cent. to Salvador, and 20 per cent. to Nicaragua, whereas in the nineteenth century only 30 per cent. belonged to Guatemala, 45 per cent. to Salvador, and 25 per cent. to Nicaragua, showing an evident tendency to a displacement of the activity southward and an increase in Nicaragua.

"To justify these figures one can say that several volcanoes became extinct in Guatemala, and that none was extinct in Salvador or in Nicaragua, but, on the contrary, that two were born in Salvador, Izalco, in 1770, and Ilopango, in 1880, and one was born in Nicaragua, that of Las Pilas, in 1850.

"Nothing similar can be feared in Panama, as no trace of any local volcanic activity may be found on that Isthmus, whose rare and small seismic vibrations come from distant centers."

Train Lighting by Electricity.

In a recent paper before the St. Louis Railway Club, Prof. Geo. D. Richardson sketches the history of car lighting in general and gives a very interesting account of the present state of train lighting by electricity in particular.

After tracing the development of train lighting from penny candles to Pintsch gas, the author dwells on the great advantage of the electrical incandescent lamp, and then proceeds to consider the various methods which have been used for lighting trains by electricity, and which may be grouped under three general heads, according to the source of current supply—the storage battery alone, the dynamo alone, or the dynamo and the storage battery combined.

"The use of storage batteries on trains dates from October, 1881, when a Pullman car running between London and Brighton, England, was equipped with storage batteries which were charged at London during the night by a special engine and dynamo. In April, 1885, the Pennsylvania road equipped eight parlor cars with storage batteries." Other roads built took up this system, but the accumulators of that day were far from perfect, and in several cases battery lighting was abandoned. "The early practice was to run the cars to the charging station, where the exhausted cells were removed and replaced by others freshly charged. This required much hand labor and the handling was found to be very hard on the cells. The later practice is to charge the batteries while the car is lying in the yard for cleaning, or to charge them while the train is running. One of the best illustrations of the simple battery system is that used on the Burlington Limited, running between Chicago and Minneapolis. Each car carries forty-eight accumulator cells, weighing fifty-six pounds each. These are carried in trays holding six cells apiece, four trays being carried in a box, one on each side of the car. The battery equipment is less than two per cent. of the average weight of the cars in these trains. Each train leaves one terminal in the evening and arrives at its destination the next morning. While the yard men are cleaning the train, the batteries are charged without being removed.

"On account of the deficiencies of the early storage batteries, various attempts have been made to operate electric lamps without batteries. The simplest way would be to drive the dynamo directly from the car axle, but some source of power must then be supplied to operate the lamps when the train is at a standstill. Other sources of power were therefore sought. In 1884, Preece tried an engine operated by compressed air pumped into a reservoir by a pump attached to the car axles. Similar schemes were patented in this country by Moskowitz. In a few cases an oil engine has been tried, and it has even been proposed to use the compressed gas now used for lighting to drive a gas engine and a dynamo. Another plan was to place a steam boiler with engine and dynamo in the baggage car, or in a special car for furnishing light and steam heat. This was tried on an English road, and also was used for about two years (1890-1892) on the Chicago, Milwaukee & St. Paul road. The more common and successful plan is to place the engine and dynamo in the baggage car and obtain steam from the locomotive boiler." Such a dynamo is generally used in connection with a storage battery, which takes care of any fluctuations of loads and provides a source of current when for any reason the dynamo stops running.

"From the beginning, engineers have looked upon the car axle as the most economical source of power for the electric lights. The locomotive develops power much more economically than a small high-speed engine; it causes no vibration when the train is standing; if made to regulate automatically, the cost of attendance is reduced to a minimum, the amount of power required is so small as not to tax the locomotive boiler or engines, and practically all the cost of power is that of the extra coal burned at the locomotive. With the power derived from the axle, each car may be separate, or may be connected with others, as desired; may be placed on a run of any length; has no vibration to disturb the wakeful sleeper; contains no elements of danger; is always ready in the evening or morning, or when going through tunnels; requires little care. The car axle as a source of power has, therefore, proved very attractive to engineers, and also proved to be beset with many difficulties. The three greatest difficulties are that the speed of the train varies so as to tax to the utmost whatever regulating apparatus may be devised; the apparatus is almost necessarily under the car and exposed to the weather; the universal use of bogie, or swivel trucks on American cars complicates the problem of maintaining proper mechanical connection between the axle and the dynamo when rounding curves and crossing frogs and switches. In Europe it is usual to mount the dynamo on the car body, for the car axle is always practically at right angles to it." The power is generally transmitted by means of flat belts of link or solid leather, or of camel's hair, but in some systems a friction drive is used, a flat-faced pulley on the armature shaft being pressed against a larger flat-faced pulley on the car axle. Gearing is also employed by some inventors.

One method of keeping the voltage at the lamps constant while the speed of the train varies, is to secure a variable ratio of reduction between the car axle and dynamo. Below a certain limit of speed of train it is impossible with any system to maintain proper operation of the dynamo, and some automatic device must be provided to cut the dynamo from the battery and lamp circuit below the critical speed. Above this speed, the dynamo may be kept at constant speed by means of friction cone pulleys, as was done by Barrett and by Moskowitz. The plan of Stone, in England, and of Gould, in America, is to maintain the speed constant by allowing the belt to slip.

A more common way of securing constant output from the dynamo is to let its speed vary with that of the car axle, and to change the strength of the magnetic field to compensate any changes in speed.

"The method adopted by the Consolidated Railway Electric Lighting and Equipment Company is to have a small motor connected with the adjustable arm of the resistance box and governed by a magnet in the main circuit; this motor automatically adjusts the resistance in series with the shunt field coil, so as to strengthen or weaken the magnetic field to compensate for any changes in speed above the critical speed of about 15 miles per hour. Personal observation of the working of this device on the Santa Fe road last December showed that, after the dynamo was connected with the lights, a sensitive Weston volt-meter indicated no perceptible variation of voltage between fifteen miles and the highest speed attained, probably forty miles per hour. In a few cars there was a slight but gradual change at the critical speed when the lights were shifted from the dynamo to the battery or vice versa. In no case was the fluctuation objectionable, and it was probably not noticed by the passengers. In the Dick system the resistance is regulated by an electromagnet. Another method of regulation is that formerly used by Moskowitz and now used by Vicarino in Europe, namely a differential winding on the dynamo field magnets.

All the axle-lighting systems employ a storage battery as an equalizer and an auxiliary. Sometimes one battery is used and sometimes two. "Generally speaking, the systems which use two batteries charge one while the train is running in one direction and the other when the direction of the car is reversed, the lamps being supplied principally from the battery which is not being charged at that time. Some of the manufacturers prefer to supply the whole train from one outfit in the baggage car, others prefer to have each car equipped with its own device in order that each car may be a unit in itself and perfectly independent."

The author quotes many figures from published accounts of the cost of electric train lighting, and concludes that for equally good illumination it can compete with oil or gas in point of economy, while its general advantages place it far in the lead.

The Sanitary Cleaning of Galveston.

The principles of the sanitary regulation of cities are fairly well established, and in civilized communities generally are reduced to a simple and unobtrusive routine, being for the most part of a preventive rather than an aggressive character. But the Anglo-Saxon world-police, reducing to order the uncivilized and unruly tribes of the earth, often find it necessary to make sanitation a very active matter indeed, making up by short, sharp methods for long arrears of native neglect. England has cleansed Augean stables all over the world; the United States are taking their turn at the same sort of labor in Cuba, Porto Rico, and the Philippines.

It is rare, however, that the sanitary engineer has so suddenly imposed and trying a problem as Galveston presented after the great storm of Sept. 8, 1900, and the adaptation of methods to the dislocated state of the city affords an interesting study. *Engineering News*, in an extended extract, presents the substance of Mr. George A. Soper's report, to the Chamber of Commerce of the State of New York, of his work in charge of the sanitary restoration of Galveston after its wreck. At the beginning he sets out the conditions which were to be met—the usual outlets for waste destroyed or temporarily useless, drains and gutters choked, outhouses demolished, the contents of vaults and cesspools swept through the city; an army of rescuers, curiosity-seekers, and adventurers added to the surviving population and seeking shelter in the insufficiently cleaned ruins; fouled upholstery, waste of all kinds, and garbage, thrown out without thought of final disposal, decomposing in the yards, streets, and alleys; a "pest of flies," an epidemic of diarrhœa, and the certainty that any acutely infectious disease, once introduced, would spread with great rapidity, and, under "shotgun quarantine," would prove "a greater blow to the city than the storm."

The general plan of immediate procedure adopted was to open a line of easy outlet for the filth by means of an efficient system of street cleaning, and to bring all available pressure to bear on householders to compel observance of sanitary ordinances. Insistence on the deposition of all garbage and refuse outside in proper receptacles, and provison for prompt removal, effected a rapid disposition of all wastes. Next, a sanitary department was organized:

"(1) The city was divided into five sanitary districts. The area of each district was inversely proportional to the density of the population and to the quantities of refuse which required removal. The force was disposed of in the districts in such a way that the garbage, papers and the like, which accumulated with tolerable regularity, could be removed by carts. The carts followed routes which were covered daily in the thickly populated sections, and three times a week in the rest of the city.

"(2) The number of garbage carts belonging to the health department was greatly increased, and a competent foreman was put in charge of the corps. The garbage was hauled to the east end of the city, and dumped where it might be burned by the aid of house wreckage.

"(3) Dead animals were removed at the owner's expense, and referred to the foreman of the garbage carts for incineration near the dumps.

"(4) Paper, house-sweepings, etc., were collected in large drays. The paper and other dry refuse was used to fill land.

"(5) A third corps was engaged in collecting and disposing of the offensive accumulations, other than garbage, which had gathered in streets and alleys. The force consisted of high-bodied coal drays of 36 cu. ft. capacity, and laborers provided with hoes and shovels. The drays and laborers were divided into gangs; three laborers to one dray, and from two to four drays to one gang, afforded the most satisfactory results. With a haul of 3 1-3 miles, and an average of 8 1-3 loads per day, the cost of scraping and removing this material was 67.3 cts. per cu. yd.

"(6) A small corps of sanitary inspectors was put to work in the various districts. Its duty was to visit private premises for the purpose of inspecting the condition of yards and outhouses, to give sanitary advice, and if necesary to serve board of health notices that householders would be required to put their property in satisfactory order within a brief period. The men had note-books in which the conditions found were recorded and reported to me at the close of each day.

"(7) There was a force of carts and men detailed to distribute disinfectants. Lime, carbolic acid, sulphate of iron and creolin were used in places from which objectionable matters were taken. Stagnant gutters, foul-smelling alleys, and private and public outhouses frequently received such treatment before it was expedient to clean them out. For work of this kind, unslaked lime, distributed as generally as possible over the offensive area, was found useful. A saturated solution of copperas was occasionally employed to arrest decomposition. Creolin, mixed with water, was used in a watering cart employed to sprinkle streets in the business portion of the city. The watering cart held about 600 gallons, and to nearly this quantity of water half a barrel of creolin was added. A stronger mixture would have been desirable, but would have probably caused complaint from pedestrians. The creolin produced an agreeable counter odor to the emanations from the gutters, and appreciably reduced the number of flies in the streets which were sprinkled. Crude carbolic acid was used with good effect in treating stagnant pools of water which were offensive because of decomposing organic matter contained by them. Whenever possible, shallow pools were drained off or filled with dry sand, broken bricks or shells. If very shallow, a thorough raking facilitated an absorption of the water by the soil. Special directions were given in all cases to use disinfectants in such a way that they might reach all the particles of the offensive substances to be treated.

"It was necessary to dispose of the bodies of dead persons and animals by burning and by burial, and circumstances usually required that this should be done close to the place where the bodies were found. Owing to the fact that the ground water in Galveston lies within a few feet of the surface of the ground, burning was the method of disposal generally followed. The bodies were placed upon large bonfires which were kept burning until the remains were consumed. Where burial was necessary, it was found desirable to use quicklime in the trenches."

Five hundred blocks of streets, alleys, and gutters were cleaned and more than 2,000 cubic yards of decomposing refuse were removed in less than two weeks. Regular collection of refuse was established. The indifference and inattention of the people to sanitary regulations were largely overcome, and they were led to aid the work of the department. None of the dreaded epidemic diseases gained a foothold.

Mr. Soper, upon his departure from Galveston, at the request of a committee of physicians made a series of suggestions for continuing the work. These were substantially: Careful observance and enforcement of health ordinances; regular collection and disposal of refuse; assignment of a special force to the correction of particularly bad local conditions; final disposal of all wreckage by burning; careful watch for and isolation of infectious diseases; continuance of the ordinary arrangement for street cleaning and night-soil removal; cleaning of streets and gutters from obstructions, and direction of liquid wastes into sewers, rather than into the streets, so far as possible; examination, cleaning, and flushing of sewers.

The Lawrence Filter Plant.

THE Lawrence filter was not the first sand-filtration system installed in the United States, but for some years it was the best known—partly because (until the Albany filter was built) it was the largest, partly because its active and enlightened management made it a kind of school of water purification whose disciples spread its traditions wherever they went. Follow back the career of the able men now engaged in the field of public water supply in the United States, and it will in a very great number of cases lead to Lawrence. The historical review of the installation and maintenance of the filter which Messrs. Morris Knowles and Charles Gilman Hyde present before the American Society of Civil Engineers has therefore an interest warranting notice, even though the Lawrence plant has long been surpassed in importance by the newer and larger filters at Albany, Pittsburg and Philadelphia. The paper, as explained in the introductory paragraph, was undertaken "in order that the story of this interesting engineering work, and, particularly, an account of its operations, might be recorded in one narrative with all necessary data at hand for a study of conditions and effects produced thereby." To this end the paper is accompanied by a remarkably full set of tables, with diagrams and photo-engravings giving exact and definite knowledge of the plant, its operation, and its results. Only a very brief summary can be attempted here.

The city is seventh in population in the State of Massachusetts, compactly built on an area of about 7 square miles, on the banks of the Merrimac. The population has grown from 3,577 in 1847 to 62,559 in 1900. It is a distinctively manufacturing city, characterized throughout by hygienic conditions rather above the average. The watershed of the Merrimac, mountainous in its upper portions, lower down is flat and sometimes swampy. Its total area above Lawrence is estimated at 4,630 square miles, on which is a population of about 500,000. The tributaries have been developed for water power, and the attendant manufacturing wastes are turned into the stream. The State Legislature in 1878 made the Merrimac a free receptacle for sewage, and Mr. Hiram F. Mills estimated the sewage entering the river during the period 1887-1890 at 1 gallon to every 600 gallons; in 1900 it is estimated at 1 gallon to 40 gallons in the driest times, or 1 gallon in every 200 gallons of the average flow. Usually, the water at the Lawrence intake shows only about 10 parts per million of suspended matter; in April, 1895, during a severe freshet, it was found to carry 1,110 parts per million, of which 57 parts represented organic matter lost on ignition. The material settles rapidly, so that in a few days after a severe freshet the water reassumes its normal character.

When the water works were constructed in 1873-1876, water was taken directly from the river through an iron and brick conduit to a well under the pumping station, and further provision for clarified water was made by construction of a stone and brick filter gallery, 8 feet in width and height, and 300 feet long, with its bottom level 11 feet below usual low water, extending down stream at right angles with the direct intake. The water from the gallery was to be used when the river was carrying an undesirable amount of suspended silt, but when it was built it was uncertain that a full supply for all time could be secured through this gallery. In the first annual report of the Water Board, Jan. 1, 1877, it was stated that sufficient water would not percolate, and an excavated channel between the structure and the river was necessary. The channel was enlarged in 1878. By 1883 it became manifest that the gallery was silting up, most of the water coming from the land side, which source was quite inadequate and indeed inconsiderable in comparison with the city's consumption. Typhoid, following the appearance of the same disease up stream, rose to excessive extent in 1890. A conference in 1891 led to better understanding of the need of improved water supply, but developed a diversity of opinion as to whether filtered Merrimac water or a new supply from uncontaminated ponds in New Hampshire should be used. A very broad charter granted the Salem Water Company put obstacles in the way of the latter project; Mr. Mills' experiments, in a long series beginning in 1886, had demonstrated that intermittent sand filtration would render the Merrimac water entirely satisfactory and safe; and on June 22, 1891, the water board recommended to the city councils that the use of Merrimac water be continued, but that it be filtered, the system of filtration to be determined later. In February, 1892, the advice of the State Board of Health was asked; they felt unable to advise any of the rapid mechanical filters then in use, but they did advise that by slow intermittent filtration at the rate of 400,000 gallons per acre per day, bacteria could be very completely removed. In June of the same year they advised the Lawrence water board that with sand filters of proper materials 5 feet deep, 1,500,000 gallons per acre per day could be filtered with resultant satisfactory purification, but that it would be necessary to free the river water from excessive sediment during freshets before applying it to the filters, which could be located conveniently on the hill above the reservoirs. A coarse-sand filter on the river bank would accomplish the preliminary clarification, and even of itself markedly decrease the death-rate—and the excessive mortality from typhoid demanded the immediate adoption of some method of purifying. The water board concluded that a filter on the river bank presented the more feasible project, and "decided to proceed with its construction according to plans and directions to be given by the State Board of Health."

Ground was broken on September 10th, and after some vacillation on the part of the city councils, due to uncertainty as to the promised action of the filters, the filter was completed September 20, 1893, at a cost of $65,000, and has continued to furnish the city with filtered water to the present time.

It is somewhat irregular in outline, extending along and beyond the old filter gallery to a length of about 750 feet, with an average width of about 150 feet and an available filtering surface of 2.36 acres. It is divided by transverse carriers into twenty-five portions, or beds, each with an average width of 30 feet. Each of these beds is a shallow valley, with a flat bottom five feet wide, and sloping sides rising 1 in 10 to a five-foot intervening ridge. The bottom of the filter, as excavated to receive the filtering material, was thus waved, with flat valleys in which the underdrains were placed and low ridges between. The underdrains deliver to the old gallery or the main conduit extended from it. The underdrains were covered first with 4 to 6 inches of 2-inch gravel, upon which were spread successively 2 inches of 1½-inch gravel, and 1 inch each of ¾-inch, ⅜-inch, and 3/16-inch gravel and 1 inch of coarse mortar sand. The courses each spread out a little beyond the one below, until the last course was spread out to a width of 20 feet. Over the center lines of the underdrains, extending 5 feet each side, was placed a body of .25 mm. sand 5 feet deep in the center; over the intervening ridges, extending 10 feet each side, was placed a body of .30 mm. sand 3 feet deep in the center.

The depth customarily maintained is one foot over the crowns of the bed. The more slowly the process is conducted, the smaller will be the amount of entrained air and the less the loss of head. Undue haste in filling actually causes loss of time. When the filter becomes clogged, the inlet water is shut off, pumping is maintained at a constantly decreasing rate, and when the water in the beds has passed sufficiently below the surface for laborers to work, the clogged surface is scraped off with shovels, wheeled away in barrows, the surface raked and smoothed, and the filter again put in service. The scraped-off sand is washed, and dumped over a paved slope ready for replacement on the filter.

The total cost of maintenance reached $9 per million gallons in 1897, but for 1899 and 1900 was only $7.70 per million; this includes removal of snow and ice, the removal of which costs about $2 per million gallons. The efficiency, as shown by averages of six years (1893-1899) is indicated by the removal of 11.6 per cent. of the color, 3.4 per cent. of the free ammonia, 52.8 per cent. of the albumenoid ammonia, 50 per cent. of the nitrites, and about 98.9 per cent. of the bacteria. It is impossible, however, to do justice to the statistical portion of the paper in the space of a review. The details of operation and efficiency are presented in admirable fulness and clearness, and those particularly interested in the subject can follow them to satisfaction and profit in the original paper.

Submarine Cables.

In a review of the cable systems of the United States and Great Britain, by Captain George O. Squier, U. S. A., which has recently appeared in the *National Geographic Magazine,* the author naturally lays particular stress upon their military importance, but his paper is also of general commercial and engineering interest.

He says that the history of the Spanish-American war "is largely a story of 'coal and cables.' That war for the first time demonstrated the dominating influence of submarine cable communications in the conduct of a naval war, and as a result of it the principal maritime powers with colonial possessions are at present elaborating their 'cable policy.'" Germany has already laid an independent cable to the United States, touching only at the Azores, and is contemplating the establishment of a cable network covering her own possesions and Holland's in the East. France intends to have an "all-French" system connecting her with all her colonies, but at present no submarine cable system can be compared with Great Britain's, which binds the whole Empire "together in one vast intelligence transmission system, with London at its center.

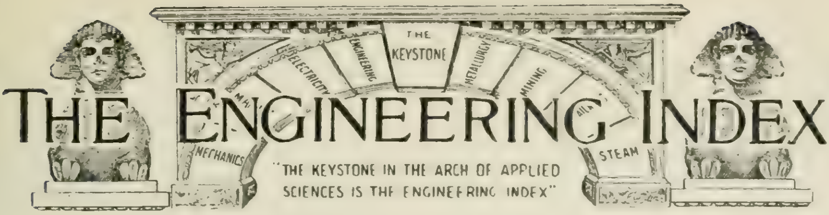
"An essential and necessary condition which has guided in the conception and realization of this cable system has been that none of the lines shall touch foreign soil." In the proposed British-Pacific cable, this principle is responsible for the unprecedentedly long span of 3,500 nautical miles from Vancouver to Fanning Island, which will place this cable at a permanent commercial disadvantage with those of shorter spans.

The United States, though more favorably situated in the matter of way stations across the Pacific, will also be guided by political considerations in laying their first cable to the Philippines. Judged solely from a commercial and technical point, a cable by way of Alaska, the Aleutian Islands and Japan possesses many advantages. The spans would be much shorter, the cable would be laid in comparatively shallow waters, and there would be a considerable and developable local traffic. But it will be necessary for political and military reasons to connect the advance posts in the Pacific with the States, and to have a cable entirely under American control in war as well as in peace. Perhaps the best solution of the matter will be to lay cables by both the Hawaiian and Alaskan routes, one serving as a duplicate for the other. Captain Squiers believes that it will be necessary to connect Porto Rico directly to the United States by cable, and he gives an estimate of the cost as follows:

Trans-Pacific cable via Hawaii and Guam, $12,000,000; Hawaiian inter-island system, $150,000; Philippine inter-island system, $250,000; Alaska telegraph system, $450,000; Trans-Pacific cable via Alaska and Alaskan cable system, $10,000,000; Tutuila Island to the British station at Fiji, $650,000; United States to Porto Rico, $1,500,000. "This estimate, which is necessarily a very general one, shows that with an expenditure of $25,000,000, or perhaps $30,000,000 at most, the United States can have a telegraph system connecting all their possessions, and they will be wise if they pursue a broad, vigorous and even lavish 'cable policy.'

"The cable question is one of the most important of the present hour, unique in that American commerce, diplomacy and sea-power—in fact the most efficient means of advancing and securing the benefits of civilization itself—happily conspire in demanding its early solution."

THE ENGINEERING INDEX



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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am.Ins.of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift fur Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Arch.

The Riverside Cemetery Bridge, Cleveland. Illustrated description of a light two-hinge arch bridge of 142 ft. span, designed to harmonize with park-like surroundings. 700 w. Eng Rec—April 20, 1901. No. 40358.

Bascule.

Page Bascule Bridge Over the Chicago River at Ashland Ave. Illustrates and describes two designs on the Page system, one a high-truss and the other a low-truss design. 3000 w. Eng News—April 25, 1901. No. 40569.

The Ashland Avenue Bascule Bridge, Chicago. Illustrated description of a two-leaf structure with about 150 ft. clear span, operated by gears which are driven by electric motors, and meshed into racks on the top chord of the shore end leaf. 2100 w. Eng Rec—April 27, 1901. No. 40581.

Bearings.

Adjusting the Bearings of Long and High Bridge Spans. Describes methods of repairing roller bearings by wedging the shoes so as to free the rollers. 800 w. Eng Rec—April 13, 1901. No. 40301.

East River.

Construction of the New East River Bridge. Considers the cables and roadway, giving illustrations. 1300 w. Sci Am—April 20, 1901. No. 40351.

Erecting the End Spans of the New East River Bridge. Illustrated description of heavy high false work and travelers and their use in erecting spans of 300 ft. each. 2000 w. Eng Rec—April 27, 1901. No. 40583.

The Suspended Structure for the New East River Bridge. Illustrated description of this part of the work, comprising the stiffening trusses, transverse bracing and floor framing, giving specifications for material and workmanship. 2000 w. Eng News—April 18, 1901. No. 40376.

Highway Bridges.

Contracting for Highway Bridges. A statement of the reasons for the inadequacy of many structures comparatively new, with suggestions on the best methods of securing new bridges. 1200 w. Eng Rec—April 27, 1901. No. 40577.

Highway Bridge Contracts. R. H. Phillips. A discussion of the reasons for poor highway bridge work, with suggestions for improvements in the award of contracts. 2100 w. Eng Rec—April 20, 1901. No. 40357.

Melan Arch.

Melan Arch Bridges Over Fall Creek, Indianapolis, Ind. Illustrated description of two concrete-steel bridges of the Melan type, recently constructed. 1100 w. Eng News—April 11, 1901. No. 40274.

Reconstruction.

Reconstruction of the Missouri River Bridge at Glasgow, Mo.; Chicago & Alton Ry. W. D. Taylor. Describes the old bridge and the new, giving an account of the interesting features of the construction work. Ill. 3000 w. Eng News—March 14, 1901. No. 40340.

Specifications.

General Specifications for Railway Bridges in North America (Grundzüge für die Berechnung und Construction der Eisenbahnbrücken in Nordamerika). Prof. J. Melan. An abstract of the general specifications for steel bridges recently issued by the American Bridge Co. 2400 w. Zeitschr d Oesterr Ing u Arch Ver—April 5, 1901. No. 40436 B.

Wooden Bridge.

Bridge Over the Macleay River, New South Wales. Illustrated description of a structure with spans much longer than any hitherto attempted in the Australian colonies. 800 w. Engr, Lond—March 29, 1901. No. 40245 A.

CANALS, RIVERS AND HARBORS.

Bristol, Eng.

The Port of Bristol. An account of the proposed improvements in docks, with a review of the history of this port. Maps. 4500 w. Builder—March 30, 1901. No. 40221 A.

Canada.

The Soulanges Canal Works, Canada. C. R. Coultée. The present article gives an illustrated description of the place, profile and cross-section, guard lock, culverts, draw bridges, locks, etc., of a canal representative of modern hydraulic engineering of this class. 4800 w. Eng News—April 18, 1901. Serial. 1st part. No. 40373.

The Water Ways of Canada. Concerning the unrivaled rivers, lakes, and canals, the traffic, revenue, etc. 2300 w. U. S. Cons Rept's, No. 1013—April 17, 1901. No. 40326 D.

Chicago Canal.

Expert Commission's Plans for Increasing the Flow Through the Chicago Drainage Canal. Explains the two plans submitted, and a summary showing their conclusions and the manner in which they have been reached. 1400 w. Eng News—April 4, 1901. No. 40150.

Dredges.

The Maintenance of Centrifugal Dredging Pumps. A statement of the results of experience with the hydraulic dredges of the Mississippi River Commission. 1000 w. Eng Rec—April 20, 1901. No. 40361.

Dry-Dock.

Construction of the New Dry-Dock at the Skinner Shipyard, Baltimore. Plans and sectional drawings showing the methods of construction, with an account of the difficulties which have been met in the work. 1200 w. Marine Engng—April, 1901. No. 40211 C.

Floods.

Increasing Height of Floods in the Lower Mississippi; the Problem and Its Solution. L. W. Brown. Slightly condensed from a paper read before the Louisiana Engng. Soc. A statement of facts and a discussion of the cause and the remedy. 5300 w. Eng News—April 18, 1901. No. 40375.

Harbor Improvement.

Description of Coos Bay, Oregon, and the Improvement of Its Entrance by the Government. William W. Harts. Description of the north jetty and the conditions prior to the commencement of operations, methods used, etc. Ill. 8000 w. Pro Am Soc of Civ Engs—April, 1901. No. 40523 E.

Final Report of the Dynamiting of the Brunswick Outer Bar, Ga. Information concerning the work and the cost. 1400 w. Eng News—April 18, 1901. No. 40378.

Hydro-Electric Station.

The Sarpsfos Hydro-Electric Station in Norway (La Station Hydro-Electrique de Sarpsfos, Norwège). A. B. An article from the *Zeitschrift für Bauwesen*, giving an illustrated description of this plant, which will ultimately develop 24,000 H. P., and transmit part of it long distances. 1200 w. Génie Civil—March 23, 1901. No. 40443 D.

Inclined Planes.

Austrian Canal Projects From a Mechanical Engineering Standpoint (Unsere Canal-Projecte vom Standpunkte der Oesterreichischen Maschinen-Industrie). Victor Schönbach. A general review of some Austrian canal projects and the proposed inclined-plane lifts. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—April 6, 1901. No. 40430 D.

Irrigation Pumping.

Electric Power for Irrigation Pumping at Bakersfield, California. Illustrated description of an interesting irrigation system. 2200 w. Elec Wld & Engr—April 6, 1901. No. 40206.

Madagascar.

The Canal of the Pangalanes, Madagascar (Le Canal des Pangalanes, Madagascar). J. H. Delaunay. A description, with maps and illustrations, of a waterway along the east coast of Madagascar, from Tamatave southward, forming part of a route to the capital, Tananarive. 1 plate. 2500 w. Mem d l Soc d Ing Civils—February, 1901. No. 40470 G.

Nicaragua Canal.

Volcanic Conditions on the Line of the Nicaragua Canal. Extracts from lectures of Mr. Bunau-Varilla, a distinguished French engineer, on the probability of volcanic disturbances. 1000 w. R R Gaz—April 26, 1901. No. 40571.

Nile.

Improvements on the Nile. Sketch of the present state of the work on the Assouan Dam, and other work directly connected therewith, with statements of the benefits contemplated. 4000 w. U. S. Cons Repts, No. 1019—April 24, 1901. No. 40397 D.

Sea Walls.

The Delaware Avenue Improvement, Philadelphia. Illustrated description of heavy concrete and timber sea walls about one-mile long; the method of making concrete blocks and setting them on pile foundations is described in detail. 3000 w. Eng Rec—April 20, 1901. No. 40355.

Water Rights.

Water-Power Plants in France (Les Usines Hydrauliques Publiques). Dr. Louis Rachou. A criticism of the French law governing the development of water-power on rivers in France. 2000 w. Génie Civil—April 6, 1901. No. 40450 D.

CONSTRUCTION.

Building Construction.

The Additions to the Mutual Life Building, New York. Illustrated description of the complicated cantilever foundation girders and wall columns in a high office building. 2500 w. Eng Rec—April 6, 1901. Serial. 1st part. No. 40179.

Building Failures.

The Court of Final Resort of New York on the Failure of the Ireland Building. Full text of a decision exonerating from blame the owner of a building which fell during construction on account of improper foundations for columns. 3000 w. Eng Rec—April 20, 1901. No. 40365.

Compressed Air.

Observations on Compressed Air Illness. Frederick R. Wainwright, in *The Lancet*. On the effects from prolonged working in compressed air and the treatment of recompression. 11500 w. Compressed Air—April, 1901. No. 40231.

Engineering Building.

The New Steam Engineering Building for the Brooklyn Navy Yard. Illustrated description of structural details of the new shop buildings being constructed. 1100 w. Eng News—April 25, 1901. No. 40564.

Fireproofing.

An Attempt to Devise a System of Absolute Fireproofing for Interior Steel Construction. Description, with illustrations of the latest improvements of the U. S. Clay Mfr. Co., and their adaptation in detail to buildings. 1200 w. Br Build—April, 1901. No. 40588 D.

Foundations.

Analysis of Pressure on Foundations of Buildings. Letters from John H. Gregory and F. E. Robertson. Gives solutions for determining the intensities of pressures on the footing course of a building wall. Ill. 1500 w. Eng News—March 14, 1901. No. 40338.

Grain Elevator.

New Steel Elevator at West Superior. Illustrated description of a great grain-holding structure of steel at the head of the Great Lakes. 3000 w. Ir Trd Rev—April 18, 1901. No. 40354.

The Largest Steel Grain Elevator. Illustrated detailed description of an elevator just completed at the head of Lake Superior. 3300 w. Ir Age—April 25, 1901. No. 40531.

Luxfer Prisms.

Luxfer Prisms, and Prismatic Lighting Theory and Application. R. A. Wood. Reviews the laws of refraction and reflection of light, on which these prisms are based, and how to determine what prisms to use. 4500 w. Builder—April 6, 1901. No. 40316 A.

Moving Buildings.

Moving and Underpinning Buildings. Illustrated description of methods employed in raising, lowering and underpinning timber, brick and stone buildings in Pittsburg and vicinity. 3000 w. Eng Rec—April 27, 1901. No. 40584.

New York Subway.

Sections 11, 13 and 14, New York Rapid Transit Railway. Illustrated description of method of constructing double-track concrete subway, partly in open cut and partly in rock tunnel. 1600 w. Eng Rec—April 13, 1901. No. 40302.

Roads.

Construction and Care of Earth Roads in Illinois. Ira O. Baker. Extract from a bulletin issued by the Illinois Agricultural Experiment Station. 3700 w. Eng News—April 18, 1901. No. 40377.

Recent Road Construction in Massachusetts. A review of the report of the State Highway Commission, describing the method of building various classes of highways, and of keeping them in repair. 2100 w. Eng Rec—April 6, 1901. No. 40175.

Road Maintenance in New Jersey. A statement of a method of maintaining roads by continuous rather than general repairs. 2200 w. Eng Rec—April 20, 1901. No. 40300.

Specification for Tarred Macadam Roadways. From a pamphlet issued by the National Coal Tar Co., of New York. Gives proposed specifications for grading, foundation, wearing surface, tar, etc. Also specification of Hamilton, Ont. 3300 w. Pro Age—April 1, 1901. No. 40124.

Roof Trusses.

Reinforcing and Replacing Church Roof Trusses. Illustrated description of the method of taking down 60-ft. timber trusses destroyed by dry rot, and replacing them with steel work without injuring a plaster ceiling suspended from the old trusses. 1000 w. Eng Rec—April 20, 1901. No. 40363.

Skeleton Construction.

The Steel Skeleton Construction of a Tall Office Building. J. S. Branne. An illustrated description of the construction; how the steel work is planned for a certain width, length and height of a building, etc., so as to combine strength and economy. 8000 w. Jour Assn of Engng Socs—Feb., 1901. No. 40132 C.

Spacing Rivets.

A Direct Method of Spacing Rivets and Finding the Position, etc., of Stiffeners in Plate Girders. E. Schmitt. Discussion of this paper continued from February, 1901. 5000 w. Pro Am Soc of Civ Engs—April, 1901. No. 40525 E.

Steel Buildings.

Steel Buildings for Export. H. G. Tyrrell. Illustrated description of designs, giving approximate cost of material and shipping. 2400 w. Eng News—April 11, 1901. No. 40275.

Tunnels.

Notes on Tunnel Work, Japanese Government Railways. Information taken from the annual report of the Imperial Government Railways on difficulties encountered in tunnel work. 1000 w. Ry & Engng Rev—April 13, 1901. No. 40290.

Sewer Tunneling in Fine Sand in Brooklyn. Illustrated description of the heavy timbering required for a 3½ ft. brick sewer in running sand. 1900 w. Eng Rec—April 27, 1901. No. 40578.

The East Boston Tunnel Extension of the Boston Subway. Illustrates and describes the essential features of the work of constructing a tunnel under the harbor. Also editorial. 4600 w. Eng News—April 4, 1901. No. 40148.

The Kellogg Tunnel, Bunker Hill and Sullivan Mines, Idaho. Ulysses B. Hough. An illustrated account of the tunnel constructed for the purpose of developing mines, the aim from the outset being to make the greatest possible progress. 1200 w. Eng News—April 25, 1901. No. 40568.

The Re-lining of the Coudray Tunnel. Illustrated description from *Centralblatt der Bauverwaltung,* of a traveling steel center permitting the passage of trains and enabling workmen to tear out and rebuild a tunnel arch. 700 w. Eng Rec—April 20, 1901. No. 40362.

MATERIALS.

Cement.

Cement and Mortar Testing. A discussion of the different purposes of neat and sand tests of cement. 1000 w. Eng Rec—April 6, 1901. No. 40173.

Concrete.

The Revised Concrete Specifications of the New York State Canals. An outline of requirements which permit balancing the aggregate, call for machine mixing except in small work and give minute directions for placing the concrete in molds. 1400 w. Eng Rec—April 27, 1901. No. 40580.

Forest Restoration.

Pennsylvania Forests and What Is Necessary to Their Restoration. Joseph T. Rothrock. Considers the forests as they were, are, and ought to be, and what is necessary to bring about the desired condition. Also discussion. 10000 w. Pro Engrs' Club of Phila—April, 1901. No. 40527 D.

Reinforced Concrete.

Brick and Concrete Metal Construction. Papers presented at the October meeting of the Boston Soc. of Civ. Engs. Deals with the economy, strength, various uses, etc., reviewing the systems. Ill. 6000 w. Jour Assn of Engng Socs—Feb., 1901. No. 40131 C.

Computing the Strength of Concrete Steel Beams. A simple mathematical discussion on beams built of these materials. 700 w. Eng News—April 25, 1901. No. 40567.

MEASUREMENT.

Surveying.

Primary Triangulation and Precise Levels of the United States Government Surveys. Herbert M. Wilson. An explanation of the work done by the government surveying organizations. 3000 w. Eng News—April 4, 1901. No. 40152.

Variations and Uses of the Standards of Measurements Employed in Field Engineering. Benjamin Franklin. Discusses the differences in standard and the mechanical inaccuracies. 4800 w. Pro Engrs' Club of Phila—April, 1901. No. 40529 D.

MUNICIPAL.

Asphalt Plant.

The Municipal Asphalt Plant at Winnipeg, Man. Description with information concerning cost of plant, maintenance, material, labor, etc. 1400 w. Eng News—April 11, 1901. No. 40277.

Galveston.

The Sanitary Cleaning of Galveston After the Great Storm of 1900. George A. Soper. Extract from a report made to the Chamber of Commerce of the State of New York, on the general plan, organization, and results. 1800 w. Eng News—April 25, 1901. No. 40565.

Navy Memorial.

A Water Gate for New York. A description of the design prepared by Ernest Flagg, for a memorial to be erected in Battery Park. Also editorial. 2000 w. Stone—March, 1901. No. 40282 C.

Pavements.

Coal Tar for Paving Uses. Fred. J. Warren. Tells what coal tar pitch or cement is, and the uses to which it has been applied. 1700 w. Munic Engng—April, 1901. No. 40105 C.

Expansion in Brick Pavements. Daniel B. Luten. Discusses the causes of the rumbling sounds produced by brick pavements under traffic, especially during the heat of summer; considers it due to expansion, and suggests the remedy. Ill. 800 w. Eng News—March 14, 1901. No. 40339.

The Economic Value of Paved Roads. Halbert-Powers Gillette. A letter discussing the arguments of Prof. I. O. Baker, and giving the writer's views, with editorial reply. 3500 w. Eng News—April 11, 1901. No. 40280.

Wood Paving in London. Gives the standard specification for laying wood paving, with remarks. 700 w. U. S. Cons Repts, No. 1021—April 26, 1901. No. 40544 D.

Sewage Disposal.

Septic Tanks, Pump Wells, and Filter Beds of the Draper Co., Hopedale, Mass. Leonard Metcalf. Illustrated description of an interesting plant for disposal of the sewage and wastes of a large plant for the manufacture of cotton machinery. 2000 w. Eng News—April 25, 1901. No. 40563.

The Septic Tank at Marion, Iowa. Illustrated description of the concrete septic tank of a city of 4,200 population, the septic effluent being discharged directly into a small brook. 1400 w. Eng Rec—April 6, 1901. No. 40177.

The Shone Sewerage System and Bacterial Beds at Hampton, England. Describes a system where all the sewage is pumped by compressed air and purified by contact beds and land treatment. The latter was required by the Local Government Board and effects no purification of the effluent from the beds. 1600 w. Eng Rec—April 27, 1901. No. 40586.

Sewerage.

Sewer Maintenance in Columbus, Ohio. George W. Lilly. Read before the Engrs' Club of Columbus. Illustrated paper on the methods and cost of cleaning catch-basins, manholes and sewers. 4600 w. Eng Rec—April 27, 1901. No. 40582.

The Sewerage of Nahant, Masaschusetts. E. W. Bowditch. Illustrated description of the separate sewerage system, and means taken to prevent further soil pollution. 1800 w. Dom Engng—April 15, 1901. No. 40344 C.

Street Cleaning.

City Cleansing in New York. Charles A. Meade. Sketch of the work of the street-cleaning department for the past six or eight years. It not only sweeps the streets, but collects and disposes of all refuse. 7300 w. Munic Af—Dec., 1900. No. 40249 D.

Methods of Cleaning Pavements. H. C. Innes. Deals principally with the cleaning of asphalt pavements and the appliances used. 2000 w. Munic Engng—April, 1901. No. 40104 C.

Street Cleaning in St. Paul. A description of the methods of cleaning different classes of pavement by machine and by hand. 1000 w. Eng Rec—April 13, 1901. No. 40304.

WATER SUPPLY.

Electrolysis.

Notes on the Electrolysis of Water Pipes. Illustrated description of damaged 48-inch pipes in Cambridge, Mass., with abstract of remarks made by A. A. Kundson before the N. E. W. W. Assn., on recent aspects of electrolysis. 1400 w. Eng Rec—April 6, 1901. No. 40176.

See Electrical Engineering, Measurement, and Gas Engineering.

Filtration.

The Lawrence, Mass., City Filter: A History of Its Installation and Maintenance. Morris Knowles and Charles Gilman Hyde. An account of this engineering work and its operations, that all the necesary data may be in form for reference and study. Ill. 17900 w. Pro Am Soc of Civ Engs—April, 1901. No. 40524 E.

The Upper Roxborough Filter Plant at Philadelphia. Illustrated description of a covered filter plant of 2,100,000 gallons daily capacity, with covered filtered-water basin, all the structures being of concrete. 1800 w. Eng Rec—April 13, 1901. No. 40299.

Flow.

Flow of Water in Pipes. Clinton B. Stewart. Considers briefly the nature of fluid friction, general formulas, and a diagram for use in the design of distributing systems. 1800 w. Eng News—April 11 1901. No. 40278.

Outflow of Water from Tanks or Reservoirs. Considers the time of flow of a given quantity of water through an orifice. 1300 w. Engr, Lond—April 12, 1901. No. 40516 A.

Laboratory.

The Mount Prospect Laboratory, Brooklyn, New York. Describes a station for chemical, bacterial and microscopical analysis of the complicated Brooklyn water supply. 3000 w. Eng Rec—April 13, 1901. No. 40300.

New York.

The Department of Water Supply. William F. King. Information concerning the comparative cost and utility, organization and administration, revenue, etc. 3500 w. Munic Af—Dec., 1900. No. 40250 D.

Paris.

The Water Supply of Paris. Abstract of an article in *Le Génie Civil*, giving much interesting information. Ill. 1500 w. Eng News—April 4, 1901. No. 40151.

Spring Water.

An Investigation of Spring Water (Nouvelle Méthode d'Etude des Eaux de Sources). Félix Marboutin. An account of the very complete investigation, topographical, geological, chemical and bacteriological, made of some sources of the Paris water supply by a commission, with maps. 1 plate. 8500 w. Mem d l Soc d Ing Civils—Feb., 1901. No. 40475 G.

Water Consumption.

The Effect of Water Meters on Water Consumption in the Larger Cities of the United States. George I. Bailey. Information of importance collected and tabulated, with editorial comment. Shows the average per capita daily consumption to be 137 gallons. 3200 w. Eng News—April 18, 1901. No. 40374.

Water-Works.

Water-Works in the Madras Presidency. An explanation of the requirements which led to special methods of design and construction of systems for Indian towns. 2200 w. Eng Rec—April 20, 1901. No. 40359.

MISCELLANY.

Antarctica.

Antarctica: A History of Antarctic Discovery. Edwin Swift Balch. A review of what has been accomplished in antarctic exploration. 6200 w. Jour Fr Inst—April, 1901. Serial. 1st part. No., 40157 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchanges.

Room for Improvement in Telephone-Exchange Management. R. M. Lockwood. Discusses some of the customs that irritate customers, and urges that the good will of subscribers is of more importance than quickness of service. 2500 w. W Elect'n—April 6, 1901. No. 40216.

Pacific Coast.

The Development of the Telephone on the Pacific Coast. Discusses the causes of the rapid development. Ill. 1700 w. Elec Wld & Engr—April 20, 1901. No. 40392.

Printing Telegraphs.

The Applications and Requirements of a Printing Telegraph. Romyn Hitchcock. From the *Telegraph Age*. Gives reasons why the printing telegraph operated from a key-board can never compete with the Morse key for general service, and discusses the requirements and the subject in general. 2800 w. Elec, N. Y.—April 24, 1901. No. 40543.

The Baudot Multiplex Printing Telegraph (Der Mehrfach-Typendrucker von Baudot). Hr. Grallert. A paper before the German Elektrotechnischer Verein, giving a very complete, illustrated description of this system now in use between Berlin and Paris. 12000 w. Elektrotech Zeitschr—March 28, 1901. No. 40426 B.

Space Telegraphy.

The Marconi-Dolbear Infringement Suit. E. Frederick Collins. An account of this legal controversy, giving a comparison of the theoretical claims and construction of the apparatus. 1600 w. Elec Wld & Engr—April 13, 1901. No. 40288.

The Oudin Bipolar Resonator.—Wireless Telegraphy (Le Resonateur Oudin Bipolaire.—La Télégraphie sans Fils). M. O. Rochefort. An article describing, first, an electro-therapeutic apparatus, and, second, a space telegraphy system, with various details. Ill. 1 plate. 3800 w. Mem d l Soc d Ing Civils—Feb., 1901. No. 40476 G.

The Part Played by the Antenna in Wireless Telegraphy. E. Guarini and F Poncelet. In the opinion of the writers the part played by the antenna is deduced from the mode of propagation of the electro-magnetic wave. The subject is discussed and conclusions stated. 2000 w. Elec Rev, Lond—April 5, 1901. No. 40-323 A.

Wireless Telegraphy (Ueber Drahtlose Telegraphie). Prof. F. Braun. A description, with diagrams, of the author's method, in which the oscillations in his sending wire are excited through an induction coil, instead of directly; and a comparison of his method with Marconi's. 1500 w. Elektrotech Zeitschr—March 21, 1901. No. 40422 B.

Submarine Signaling.

Submarine Signaling. A description of the system devised by Arthur J. Mundy and Prof. Elisha Gray, which has been recently tried in Boston harbor. 2000 w. Marine Rev—April 25, 1901. No. 40557.

Telephone Service.

Telephone Service Ideals. G. F. Jenks. Considers the ideal will only be reached when every business man has a telephone on his desk, and every house has a telephone in every room, and when all these telephones can readily communicate. 1300 w. Elec Wld & Engr—April 20, 1901. No. 40396.

Telephone-Telegraph.

Telephony on Telegraph Circuits (Anschaltung von Fernprechsystemen an Morseleitungen). O. Cantor. A short description of an arrangement by which telephoning is carried on over Morse telegraph circuits. Diagrams. 400 w. Elektrotech Zeitschr—April 4, 1901. No. 40-429 B.

DISTRIBUTION.

Alternating Currents.

Alternating Current Systems. H. S. Meyer. The present article discusses the advantages and disadvantages of high frequency and other points bearing on the selection of the best suitable frequency for a system. 1800 w. Engng—March 29, 1901. Serial. 1st part. No. 40235 A.

Alternating vs. Continuous.

On the Relative Advantages of Alternating and Continuous Current for a General Supply of Electricity, Especially with Regard to Interference with Other Interests. A topical discussion at the joint meeting of the American and British societies at Paris, 1900. 12000 w. Trans Am Inst of Elec Engs—March, 1901. No. 40554 D.

Dielectric Losses.

Dielectric Losses in Condensers and Cables and Their Bearing on Electrical Supply. Charles V. Drysdale. Gives a summary of the advantages and disadvantages of polyphase as compared with single-phase systems, and an account of tests made on cables and condensers. 2500 w. Elect'n, Lond—April 5, 1901. No. 40319 A.

Equalizers.

Equalizer Circuits (Ausgleichleitungen).

Prof. J. Teichmüller. A paper before the Verband Deutscher Elektrotechniker, containing a theoretical discussion and a practical example of the equalization of the potential in distributing networks, with diagrams. 3 parts. 8500 w. Elektrotech Zeitschr—March 14, 21, 28, 1901. No. 40415 each B.

Manchester.

Manchester Electricity Works. An illustrated description of the three-phase extensions put down as a temporary aid to the low-pressure system of distribution, and also of the present system of supply. 4090 w. Elec Engr, Lond—April 5, 1901. No. 40317 A.

Periodicity.

Some Notes on Changes of Periodicity. States the advantages of the reduction of the periodicity to the lowest possible value, with remarks on a change from 100 periods to 50 periods, but also applicable to changes of a lesser degree. 1500 w. Elec Rev, Lond—April 5, 1901. No. 40325 A.

Poles.

Holding Capacity of Anchors for Electric Wiring Poles. R. C. Carpenter. An illustrated account of tests of the Stonebaugh Guy Anchor, and data as to the holding power. 700 w. Sib Jour of Engng—April, 1901. No. 40520 C.

The Outlook of the Cedar Pole Supply. C. H. Worcester. An illustrated account of the work of preparing these poles for market and the comparatively limited supply. 2800 w. Telephony—April, 1901. No. 40298.

Switch.

Automatic Cut-Out Switch for Heavy Currents (Selbstthätiger Starkstrom-Hebelschalter). Friedrich Natalis. An illustrated description of a switch which is cut out automatically in emergencies, and which cannot be closed again before the automatic cut-out device is set. 1000 w. Elektrotech Zeitschr—April 11, 1901. No. 40432 B.

Underground.

Notes on Some Systems of Laying Underground Cables. Arthur Devey. Abstract of paper read before the Glasgow Section of the Inst. of Elec. Engs. The discussion of armored or unarmored cables laid direct in the ground, and pipe, or conduit systems is presented in this number. 2200 w. Elec Rev, Lond—April 5, 1901. Serial. 1st part. No. 40324 A.

Wiring.

Notes on Wiring Rules. F. Broadbent. Abstract of a paper read before the Newcastle Sec. of the Inst. of Elec. Engrs. Compares the rules and requirements of various companies on specific subjects. 4300 w. Elect'n, Lond—April 12, 1901. No. 40505 A.

Some Notes on Electric Wiring. George A. Clark. Abstract of a paper read before the Glasgow Sec. of the Inst. of Elec. Engrs. Points out some of the most serious defects, and suggests a remedy where possible. 1500 w. Elect'n, Lond—April 12, 1901. No. 40506 A.

ELECTRO-CHEMISTRY.

Accumulators.

Recent Progress in Accumulator Manufacture. John H. West. Considers the defects and disadvantages from which these appliances suffer and ways of remedying them. Ill. 2500 w. Elec Chem & Met—March, 1901. Serial. 1st part. No. 40120 A.

Storage Battery Maintenance. Thomas J. Fay. Gives tests for undesirable ingredients and explains their importance. 2800 w. Elec Wld & Engr—April 6, 1901. No. 40208.

See Electrical Engineering, Generating Stations.

Alkalies.

The Outhenin-Chalandre Electrolytic Alkali Process. John B. C. Kershaw. Illustrated description of a process for the production of alkalies and chlorine compounds by the electrolysis of solutions of sodium or potassium chloride. 1000 w. Elect'n, Lond—March 29, 1901. No. 40230 A.

Bleaching.

Electrolysis in Bleaching Textiles. Detailed description of an invention for producing bleaching liquor out of ordinary brine, the product being sodium hypochlorite. Ill. 700 w. U. S. Cons Repts, No. 1004—April 6, 1901. No. 40191 D.

Mercury.

The Electrolytic Purification of Mercury. Woolsey McA. Johnson. Describes an experiment made for clearing mercury by electro-chemical means. Ill. 850 w. Elec Wld & Engr—April 20, 1901. No. 40394.

Reflectors.

An Electrolytic Process for the Manufacture of Parabolic Reflectors for Searchlights and Locomotive Headlights. Sherard Cowper-Coles. An illustrated description of the process invented by the writer. 3500 w. Elec Chem & Met—March, 1901. Serial. 1st part. No. 40110 A.

ELECTRO-PHYSICS.

Earth Currents.

The Investigation of Earth Currents (Die Erdstrom-Erforschung). Prof. Foerster. An address before the Elektrotechnischer Verein, giving an account of the research work on earth currents on German telegraph lines carried on by a committee of the above society. 3500 w. Elektrotech Zeitschr—April 11, 1901. No. 40434 B.

Electric Inertia.

On Electric Inertia and the Inertia of Electric Connection. Arthur Schuster. Mathematical investigations. 4300 w. Elect'n, Lond—April 5, 1901. No. 40320 A.

Electric Sparks.

Rotations from Electric Sparks. Alfred G. Dell. Describes interesting experiments. 3300 w. Elec Wld & Engr—March 30, 1901. No. 40138.

Gyroscopes.

Electrical Gyroscopes. Howard B. Dailey. Illustrated description of continuously-acting gyroscopes, using static electricity as a motive agent. 2000 w. Sci Am—April 20, 1901. No. 40350.

Induction.

Induction Experiments. Emile Guarini. An account of experiments made to show that it is possible to obtain in an induced circuit a current producing the same effect as a continuous current. 2900 w. Elec Engr, Lond—March 29, 1901. No. 40225 A.

Interrupter.

A New Electrolytic Interrupter (Ein Neuer Elektrolytischer Unterbrecher). John Härdén. An illustrated description of an interrupter on the Simon principle, but with a punctured porcelain insulator instead of a punctured glass plate. 800 w. Elektrotech Zeitschr—March 21, 1901. No. 40421 B.

Laboratories.

Electrical Equipment of the New Physical Laboratories, Owens College. W. P. Steinthal. An illustrated description of the electrical arrangements for lighting, power, and experimental work. 2500 w. Elec Rev, Lond—April 12, 1901. No. 40501 A.

Magnets.

A Contribution to the Theory of Permanent Magnets (Zur Theorie Permanenter Magnete). J. Busch. A discussion of the magnetomotive force, the length of the magnetic circuit and the air gap in permanent magnets. 500 w. Elektrotech Zeitschr—March 14, 1901. No. 40417 B.

X-Rays.

The Present State of X-Ray Work. William C. Peckham. Concerning the satisfactory work now possible, and the changes made in the static machine. 1200 w. Sci Am—April 20, 1901. No. 40349.

GENERATING STATIONS.

Accumulators.

The Maintenance of Central Station Batteries. A. J. Abraham. Gives instances of the abuse accumulators receive in most electricity works, and suggestions for keeping them in a healthy condition. 1300 w. Elec Rev, Lond—April 12, 1901. No. 40502 A.

Alternating vs. Continuous.

See Electrical Engineering. Distribution.

Armature Windings.

Modern Windings for Slatted Armatures (Moderne Wickelungen für Genuthete Gleichstromanker). Alexander Rothert. An illustrated description of various windings, with a discussion of the whole subject. 2400 w. Elektrotech Zeitschr—April 11, 1901. No. 40431 B.

Dynamos.

Direct-Current Generators. Sidney H. Short. Read before the Manchester Section of the Inst. of Elec. Engs. Discussion with a view to more nearly standardizing this class of electrical machinery. 4000 w. Elec Engr, Lond—March 29, 1901. No. 40226 A.

Electric Machinery.

Apparatus for Power Distribution from Central Stations. Charles F. Scott. Considers the various types of electrical machinery, particularly generators, rotary converters and motors, showing some recent types of construction, and the characteristics of their performance. Ill. 8500 w. Jour Fr Inst—April, 1901. No. 40158 D.

Generating Set.

An 825-Kilowatt Generating Set at the Paris Exposition (Exposition de 1900: Groupe Electrogène de 825 Kilowatts). Ch. Dantin. A well illustrated description of a Carels horizontal, tandem, compound engine, directly coupled to a Kolben triphase generator. 1 plate. 2200 w. Génie Civil—March 30, 1901. No. 40446 D.

A 2200-Horse-Power Generating Set at the Paris Exposition (Exposition de 1900: Groupe Electrogène de 2200 Chevaux). Georges Henry. A well illustrated description of a vertical triple-expansion steam engine, constructed by the United Augsburg-Nuremberg Machine Works, directly coupled to a 900-kilowatt continuous-current dynamo, and to an 850-kilowatt triphase generator, built by Schuckert. 1 plate. 4000 w. Génie Civil—March 16, 1901. No. 40442 D.

Hydro-Electric Station.

Construction of the Shawinigan Water and Power Company's Plant. Illustrated detailed description of an important water-power development in Canada. 3500 w. Can Engr—April, 1901. Serial. 1st part. No. 40293.

See Civil Engineering, Canals, Rivers and Harbors; and Mechanical Engineering, Hydraulics.

Indiana.

The Power Generating and Distributing System of the Union Traction Co. of Indiana. Illustrated description of the new power house, and information concerning the lines. 9000 w. St Ry Rev—April 15, 1901. No. 40387 C.

Manchester, Eng.

Electricity Supply for Greater Manchester. Illustrated description of important extensions and three-phase transmission system. 3300 w. Elect'n, Lond—April 12, 1901. No. 40504 A.

Manhattan Elevated.

The Power Station of the Manhattan Elevated Railway. Illustrated description of the new power station on the East River, between 74th and 75th streets, New York. 4400 w. Power—April, 1901. No. 40122.

Parallel Running.

Speed Variations of Engines Direct-Connected to Alternators. A. H. Kruesi. A discussion of difficulties and means of overcoming them. The present article considers principally the calculation of crank effort, velocity and displacement. 2000 w. Elec Wld & Engr—April 13, 1901. Serial. 1st part. No. 40286.

Polyphase Generators.

The Drop of Potential in Rotary Current Generators (Spannungsabfall von Drehstromgeneratoren). F. Niethammer. A mathematical discussion, with diagrams. 800 w. Elektrotech Zeitschr—March 21, 1901. No. 40418 B.

Polyphase Machinery.

Polyphase Sub-Station Machinery. A. C. Eborall. Read before the Inst. of Elec. Engs., London. Discusses the equipment and operation of polyphase substations, with features of working and a comparison of different types of machinery, etc. 2 parts. 16500 w. Engng—March 22 and 29, 1901. No. 40108 each A.

Rotary Converters.

The Design of Rotary Converters (Ueber die Berechnung Rotirender Umformer). Hans S. Meyer. A general account, theoretical and practical, of the design of these machines, taking up each point in order, with illustrations and diagrams. 4000 w. Elektrotech Zeitschr—April 4, 1901. No. 40427 B.

Station Management.

Should Central Stations Furnish Incandescent-Lamp Renewals Free? C. A. Vallette. Read before the Illinois State Elec. Assn. Concludes that it depends altogether on local conditions and on the operating expenses. 1800 w. W Elect'n—April 6, 1901. No. 40215.

The Card System Applied to Central Electric Supply Stations. F. W. Farrerwhite. An outline of the method adopted at a central station in England, showing the applicability of this system to the requirements. 900 w. Elec Rev, Lond—March 22, 1901. Serial. 1st part. No. 40117 A.

Switchboards.

Switchboards. T. D. Boyles. Considers points in design which affect the safety and reliability. 3300 w. Engr, U S A—April 15, 1901. No. 40343.

LIGHTING.

Arc Lamps.

Arcs from Electrolytic Oxide Electrodes. Reviews an article by Mr. Ewald Rasch, appearing in the *Elektrotechnische Zeitschrift.* 1600 w. Elec Rev, N Y—March 30, 1901. No. 40098.

Remarks on an Article by Herr Rasch on a New Method of Producing Electric Light (Bemerkung zur Notiz des Herrn Rasch "Ein Neues Verfahren zur Erzeugung von Elektrischem Licht"). Prof. W. Nernst. A criticism of some of the figures for the efficiency of arc lights and Nernst lamps given by Herr Rasch, and doubts as to the commercial practicability of the Rasch electrolytic arc lamp. 800 w. Elektrotech Zeitschr—March 21, 1901. No. 40419 B.

Mechanical Equivalent.

Mechanical Equivalent of Light. Carl Hering. A discussion of the determinations of the energy required to produce a unit quantity of light rays made by Tumlirz and by Thomsen, reducing them to more convenient terms. 3400 w. Elec Wld & Engr—April 20, 1901. No. 40393.

Mercury-Vapor Lamp.

The Cooper Hewitt Lamp. Illustrated account of the high-power electric lights exhibited at Columbia University, in which a gas is used as the illuminating medium instead of the usual filament. 1000 w. Sci Am—April 27, 1901. No. 40540.

Reflectors.

See Electrical Engineering. Electro-Chemistry.

Safety Lamps.

See Mining and Metallurgy, Mining

Searchlights.

Searchlight Signaling at the Pan-American Exposition. Orrin E. Dunlap. An account of the proposed display during the months of the exposition, showing the beautiful effects and the great usefulness of searchlights. 2000 w. Sci Am Sup—April 27, 1901. No. 40541.

MEASUREMENT.

Alternating Currents.

The Influence of the Form of the Current Curve on Measuring Instruments (Der Einfluss der Kurvenform auf Messinstrumente). Dr. Gustav Benischke. A brief account, with diagrams, showing that electromagnetic instruments are affected by the curve form, while induction instruments are affected by the speed. 200 w. Elektrotech Zeitschr—April 4, 1901. No. 40428 B.

Galvanometers.

The Apparent Resistance of a Ballistic Galvanometer of the Moving Coil Type, and a Method of Allowing for the Damping Current. David Robertson. An account of experiments, describing methods and results obtained. 2000 w. Elect'n, Lond—April 5, 1901. Serial. 1st part. No. 40321 A.

Resistance Boxes.

A New Kind of Resistance Box with Rotating Contact Pieces (Eine Neue Art von Kurbelrheostaten für Messzwecke). Dr. Rudolf Franke. An illustrated description of a rheostat in which the resistance coils are cut in and out by a rotating sliding contact, instead of by plugs. 500 w. Elektrotech Zeitschr—March 28, 1901. No. 40425 B.

Precision Rheostat and Bridges with Rotating Contact Pieces (Präcisions-Kurbelrheostaten und-Brücken). Prof. M. Th. Edelmann. A short illustrated description of a Wheatstone bridge in which the resistances are cut in and out by rotating contacts, instead of by plugs. 300 w. Electrotech Zeitschr—March 21, 1901. No. 40420 B.

Stray Currents.

Earth Potential Curves from Chicago, Toledo and Columbus. Interesting curves representing the contour lines of electric pressure in the earth under the influence of the electric railway system of current distribution. 600 w. Elec Wld & Engr—April 13, 1901. No. 40287.

The Measurement of Electric Currents in Underground Pipes (Ueber Messungen der Elektrischen Ströme in den Städtischen Rohrleitungen). Sigvald Krohn. An article giving the method and results of measurements of stray currents from electric tramways in gas and water pipes, with recommendations for the avoidance of this trouble. Diagrams. 2000 w. Elektrotech Zeitschr—March 28, 1901. No. 40423 B.

POWER APPLICATIONS.

Coal Mines.

Some Notes on the Electrical Transmission of Power in Coal Mines. H. Ravenshaw. Read before the Brit. Inst. of Elec. Engrs. Discusses the special features met with in electric power plants in coal mines and gives a record of difficulties and mishaps which have come directly under the notice of the author. 3000 w. Elec Rev, Lond—April 12, 1901. No. 40503 A.

The Electrical Transmission of Power in Coal Mines. H. Ravenshaw. Read before the Inst. of Elec. Engrs., England. A discussion of the special features, and a record of difficulties and mishaps. 9000 w. Ir & Coal Trds Rev—March 29, 1901. No. 40246 A.

Comparison.

A Comparison Between Electrical and Mechanical Transmission. H. H. Holding. From a paper read before the Asso. Tech. Club of Cleveland, Ohio. Gives results showing that there is no reason why a factory cannot be driven more cheaply and advantageously by electricity than by direct mechanical means. 1600 w. Am Mach—April 25, 1901. No. 40538.

Cranes.

New Electric Cranes (Neuere Elektrisch Betriebene Hebegeuge). An illustrated account of movable cranes for shops and wharves, built by the Benrath Machine Co., and driven by polyphase motors. 1500 w. Zeitschr d Ver Deutscher Ing—March 30, 1901. No. 40403 D.

150-Ton Electric Crane at Bremerhaven Harbor (Elektrischer 150t-Krahn im Bremerhavener Hafen). An illustrated article from *Uhlands Verkehrszeitung*, giving a description of this large cantilever crane for use on the wharves. 800 w. Oesterr Wochenschrift f d Oeffent Baudienst—March 30, 1901. No. 40438 D.

Fan Motor.

The Construction of a Direct-Current Fan Motor. Illustrates and describes a compact form of fan motor easily constructed by one familiar with the use of machine tools. 1400 w. Am Elect'n—April, 1901. No. 40162.

Irrigation Pumping.

See Civil Engineering, Canals, Rivers and Harbors.

Mining Plant.

The Electric Power Station at the Pierrefitte Mines. E. Henry Davies. From a paper read before the Inst. of Min. & Met. Brief description of power plant for these lead and blend mines in the French Pyrenees. 700 w. Col Guard—March 29, 1901. No. 40264 A.

Motors.

Electric Motors: A Brief Outline of Their Characteristics. A. Saunders Morris. Suggestions as to the type of motor which should be selected for required work, and urging that more definite information be furnished to designers of electrical apparatus. 2800 w. Stevens Ind—April, 1901. No. 40367 D.

Packing House.

Alternating Current Power Equipment in a Packing House. Illustrated descriptions of the centralized power plants of Swift & Company, at Chicago, Ill., and St. Joseph, Mo. 1800 w. Am Elect'n—April, 1901. No. 40161.

Polyphase Motors.

The Distribution of Lines of Force in Rotary Current Motors (Zur Kraftlinienvertheilung in Drehstrommotoren). J. B. Krantz. A mathematical discussion, with diagram and table. 700 w. Elektrotech Zeitschr—March 28, 1901. No. 40424 B.

Power Plant.

Electrical Plant of the Curtis Publishing Company, Philadelphia, Pa. John S. Griggs, Jr. Illustrated detailed description of a plant for furnishing light, heat and power to two buildings. 3500 w. Elec Rev, N. Y.—April 6, 1901. No. 40204.

Power Plant of the Edward Ford Plate Glass Co. T. L. Farnham. Illustrated description of a plant near Toledo, Ohio which is probably the largest manufacturing plant entirely equipped with electrically driven machinery. 6000 w. Engr U. S. A.—April 1, 1901. No. 40205.

The Generation and Distribution of Power in the Olympia Mills. Illustrated description of a 5,000 H. P. plant and electric distribution system in a cotton mill at Columbia, S. C. The electric plant was cheaper in first cost, and is expected to be cheaper in operation and maintenance, than a shafting system. 3000 w. Eng Rec—April 6, 1901. No. 40174.

Pump.

See Mechanical Engineering, Hydraulics.

Switching Out.

The Switching Out of Shunt-Wound Electric Motors Without Sparking (Bedingungen des Funkenfreien Ausschaltens für Nebenschlussmotoren). Rudolf Krause. A description, with diagrams, of methods of avoiding sparking at the starting switch of continuous current motors. 800 w. Elektrotech Zeitschr—March 14, 1901. No. 40416 B.

TRANSMISSION.

Mexico City.

Power Transmission at Mexico City. C. R. Mundinger. Brief account of the water-power plants for power transmission to this city. 1400 w. Elec Wld & Engr—April 20, 1901. No. 40395.

Niagara.

Recent Developments at the Niagara Falls Power Plant. Arthur B. Weeks. Illustrations and brief description of the aluminium transmission line by means of which electric current will be sent to the Pan-American Exposition; the changes in the lightning arrester apparatus, etc. 1000 w. Sci Am—April 13, 1901. No. 40257.

Utah.

Power Transmission in Utah. J. R. Cravath. Results and lessons from the operation of the long-distance power transmission and distribution systems of the Utah Light & Power Company. Ill. 5800 w. Elec Wld & Engr—March 30, 1901. No. 40137.

MISCELLANY.

Benjamin Franklin.

Benjamin Franklin's Contributions to Electrical Science. Edwin F. Northrup. Begins a review, in some detail, of his contributions to electrical knowledge. The present article deals with his experiments on the action of points on the electric charge. 2700 w. Elec Rev, N. Y.—March 30, 1901. Serial. 1st part. No. 40097.

Carbon.

The Manufacture and Testing of Carbon for Electrical Purposes (Herstellung und Prüfung von Kohle für Elektrotechnische Zwecke). J. Härdén. A well illustrated account of the preparation and testing of carbons for electrodes, brushes, arc lights and other purposes. 4500 w. Elektrotech Zeitschr—April 11, 1901. No. 40433 B.

Glasgow Exhibition.

See Mechanical Engineering, Miscellany.

Graphite.

The Artificial Production of Graphite. Clinton Paul Townsend. An account of some of the modifications undergone by carbon, and the conditions governing them, with inferences drawn. 5800 w. Elec Wld & Engr—April 6, 1901. No. 40207.

India.

The Use of Electricity in India. George Cecil. An illustrated article telling of the development of electricity in the country. 1600 w. Elec Engr, Lond—April 5, 1901. No. 40318 A.

Lightning Protection.

The Protection of Buildings from Lightning (Ueber Gebäude-Blitzableiter). K. Strecker. The report of a committee of the Elektrotechnischer Verein, with the proposed rules for the protection of buildings against lightning. Also editorial comment. 1800 w. Elektrotech Zeitschr—April 11, 1901. No. 40430 B.

GAS ENGINEERING

Blast-Furnace Gas.

Progress in the Utilisation of Blast-Furnace Gases (Weitere Fortschritte in der Verwendung der Hochofengase zur Unmittelbaren Krafterzeugung). Fritz W. Lürmann. Abstract of a paper before the Verein Deutscher Eisenhüttenleute giving an account of the recent extensive use of blast-furnace gases in gas engines in various countries. 2000 w. Zeitschr d Ver Deutscher Ing—April 13, 1901. No. 40410 D.

Coal Gas.

Coal Gas and Its Various Competitors. Franz Schaeffer. Report presented to the International Gas Congress in Paris. A review of the production and consumption of coal gas, electricity, acetylene, water, gas, etc. 3900 w. Jour Gas Lgt—April 9, 1901. No. 40345 A.

Coke Ovens.

By-Product Coke Ovens or Improved Coal Gas Works for a City Supply—A Comparison. Frederic Egner. A discussion of this subject, especially presenting the other side of the coke oven or gas works question. 1900 w. Am Gas Lgt Jour—April 22, 1901. No. 40391.

Electrolysis.

The Effect of Stray Trolley Currents. H. E. McGowan. Gives results and conclusions from experience in connection with the Brooklyn Union Gas Co. Ill. 1700 w. Stevens Ind—April, 1901. No. 40369 D.

The Question of Electrolysis. Abstract translation from the *Journal für Gasbeleuchtung*. Continental, American and English experience, the remedy, etc. 3500 w. Gas Wld—March 30, 1901. No. 40229 A.

Gas Engines.

See Mechanical Engineering, Gas and Oil Engines.

Incandescence.

A Combination to Test the Welsbach Patent of '93. An account of competition in England and the steps being taken to test the validity of the Welsbach 1893 patent. 1800 w. Jour Gas Lgt—April 16, 1901. No. 40558 A.

A New Method of Incandescent Gas Lighting. G. Mollberg. Read at meeting of the German Gas Assn. A description of the Selas apparatus. 1200 w. Gas Wld—April 13, 1901. No. 40399 A.

Improvement in Welsbach Gaslights. An account of improvements discovered and perfected by Rudolph Langhans, an Austrian engineer, which makes the mantle stronger and maintains the constancy of the light emission, and also corrects other defects, thus making it applicable under conditions where hitherto no mantle could be used. 1300 w. U. S. Cons Repts. No. 1007—April 10, 1901. No. 40248 D.

Relation of Heating to Lighting Power of Gas with Special Reference to Incandescent Mantles. Herman Russell and Alfred H. White. Read at meeting of the Michigan Gas Assn. An account of experimental investigations. 3800 w. Am Gas Lgt Jour—April 1, 1901. No. 40153.

The Change Occurring in the Illuminative Value of Mantles with Lapse of Time. Dr. Emil Liebenthal. An account of investigations made to determine the duty afforded by the different varieties. 1300 w. Jour Gas Lgt—April 16, 1901. No. 40560 A.

The Incandescent System of Gas Lighting. On the great value of the Welsbach burner to the gas industry, and to the public, with a discussion of some of its defects. 5600 w. Engr, Lond—April 12, 1901. No. 40515 A.

India.

Gas: Its Uses in India. George Cecil. An account of conditions and the degree of progress in the use of gas, showing the country to be very slow in adopting modern improvements. 2000 w. Jour Gas Lgt—March 12, 1901. No. 40315 A.

Mond Gas.

South Staffordshire Mond Gas Scheme. Describes the South Staffordshire coal fields, whose peculiarity is the great thickness of the seams and the numerous faults, and the present conditions, and explains a scheme for the use of Mond gas as a means of economical pumping. 2400 w. Eng, Lond—March 22, 1901. Serial. 1st part. No. 40111 A.

Mulhouse.

The New Gas-Works at Mulhouse. Illustrated particulars of these new gas-works in a town in Germany. 2300 w. Jour Gas Lgt—April 16, 1901. No. 40561 A.

Power Gas.

Power Gas in France: The Pierson System. Reviews briefly the attempts made by French engineers to produce fuel gas from the poor native coal, and gives information concerning the successful process named. 2300 w. Jour Gas Lgt—April 16, 1901. No. 40559 A.

Vienna.

The Central Gas-Works of Vienna. Herr Th. Herrmann. Illustrated description of works of exceptional interest, planned on an extensive scale and finely equipped. 8000 w. Jour Gas Lgt—March 26 and April 2, 1901. Serial. 2 parts. No. 40172 each A.

MARINE AND NAVAL ENGINEERING

Balancing Engines.

On the Balancing of the Reciprocating Parts of Engines, Including the Effect of the Connecting-Rod. W. E. Dalby. Read before the Brit. Inst. of Naval Archts. The paper is wholly concerned with balancing reciprocating masses amongst themselves, taking into account the variation of the simple harmonic motion caused by the connecting-rods. Ill. and Dis. 5500 w. Engng—April 5, 1901. Serial. 1st part. No. 40329 A.

Boilers.

Experiments on a Niclausse Water-Tube Boiler. Summarized by Bryan Donkin, from a paper read at the Paris Congress. Describes the results of tests giving the evaporation from each row of tubes in a Niclausse generator, and at different rates of combustion, with heat efficiencies. 1400 w. Engr, Lond—April 5, 1901. No. 40331 A.

On a Form of Double Tube Boiler. John Irving. Read before the Brit. Inst. of Naval Archts. Illustrated description of the construction and performance of a boiler designed for the mercantile marine. 2000 w. Engr, Lond—April 5, 1901. No. 40334 A.

Water-Tube Boilers. Edwin Griffith. Read before the North-East Coast Inst. of Engs and Shipbuilders. Considers the present position of water-tube boilers from the point of view of the marine engineer. 6200 w. Engs' Gaz—April, 1901. No. 40223 A.

Water-Tube Boilers in the British Navy. A statement of the events which led to the appointment of an expert commission, and a copy of the report submitted. 2500 w. Eng News—April 4, 1901. No. 40149.

Boston Ships.

Boston Ships: Past and Present. R. G. F. Candage. Concerning the ships built in, owned and sailed into and out of the port of Boston from its settlement to the present time. 5500 w. Naut Gaz—April 4, 1901. No. 40201.

Celtic.

Celtic, Largest Vessel Ever Built. Brief description of a large vessel launched recently, designed to carry an immense cargo, but with ample accommodations for passengers. 1200 w. Marine Rev—April 11, 1901. No. 40309.

The White Star Liner "Celtic." Illustrates and describes the structural features, which are particularly interesting because of the size of the vessel and the great strength of her scantlings. 2700 w. Engng—April 12, 1901. No. 40512 A.

Channel Service.

The Cross-Channel Passenger Steamship Services. Historical review of the channel-service from the earliest use of steamships. Ill. 2200 w. Engr, Lond—March 29, 1901. Serial. 1st part. No. 40244 A.

Cylinders.

On a New Assistant Cylinder. David Joy. Read before the Brit. Inst. of Naval Archts. On recent improvements and advances in construction and efficiency. 1700 w. Engng—April 5, 1901. No. 40328 A.

Dry-Dock.

See Civil Engineering, Canals, Rivers and Harbors.

Fast Scout.

A Design for a Fast Scout. C. C. P. Fitzgerald. Read before the Brit. Inst. of Naval Archts. Describes a design for a scout of high speed and good sea-going qualities, and gives reasons for proposing such a vessel. 1400 w. Engng—March 29, 1901. No. 40239 A.

Great Lakes.

A Chicago and European Steamship Line. An account of a line of freight carriers; the first vessel having sailed from Chicago on April 24. 800 w. Ir Age—April 20, 1901. No. 40535.

Magnificent Lake Steamboats. Illustration and description of two large passenger vessels for service on Lake Erie. 1100 w. Naut Gaz—April 11, 1901. No. 40271.

New Lake Superior Passenger Boat. Illustration with brief description of the new steel passenger and freight propeller "Argo." 600 w. Naut Gaz—April 18, 1901. No. 40389.

Old-Time Lake Steamboats. Illustrated account of two famous vessels that plied on Lake Erie before the Civil War. 1500 w. Naut Gaz—April 11, 1901. No. 40272.

Guns.

Seven-Inch vs. Six-Inch Guns for Our New Armored Cruisers. Paul D. Emmons. A reply to objections made to the proposed change. 1700 w. Sci Am Sup—April 20, 1901. No. 40353.

Japan.

Trade and Shipbuilding at Nagasaki. Notes on the present position of a port rapidly becoming one of the most important in the Far East. 2300 w. Engng—March 22, 1901. No. 40106 A.

Korea.

Launch of the Pacific Mail Liner "Korea." Brief illustrated description of the largest steamship ever built in America, which is to ply between San Francisco and Hong Kong, carrying freight and passengers. 700 w. Sci Am—April 13, 1901. No. 40256.

Kronprinz Wilhelm.

New North German Lloyd Atlantic Steamer "Kronprinz Wilhelm." Describes this vessel recently launched, making another high-speed steamer of great size for this company. 900 w. Engng—April 12, 1901. No. 40514 A.

Naval Stations.

French Naval Stations. Discusses the proposed improvements providing for the accommodation of the vessels of the new navy and creating naval stations for the defence of the colonies. 2400 w. Engr, Lond—March 29, 1901. No. 40243 A.

Ore Carriers.

The New Ore Carrying Fleet of 1901. Waldon Fawcett. Discusses the changed conditions and the effect on the fleet of vessels for the Great Lakes. 300 w. Ir Age—April 25, 1901. No. 40534.

River Steamer.

Clyde River Passenger Steamer. George C. Cook. Illustrated description of a special type of speedy vessel developed to meet local conditions. 1800 w. Marine Rev—March 28, 1901. No. 40091.

Rolling.

An Instrument for Measuring the Rolling of Ships. A. Mallock. Read before the Brit. Inst. of Naval Archts. Illustrated description of a rolling indicator, which is said to give very accurate measure of the rolls in all circumstances. 3400 w. Engng—March 29, 1901. No. 40237 A.

Shipbuilding.

Shipbuilding in Germany, and the Imperial German Navy. Information compiled from various sources. 1800 w. Jour U. S. Art—March-April, 1901. No. 40130 D.

The Mechanical Equipment of the Ship-Yard. Prof. J. H. Biles. A clear explanatory discussion of the processes of shipbuilding, devoted particularly to the framing of the vessel and the punching and shearing machines used in the work. Ill. Serial. 1st part. 3000 w. The Engineering Magazine—May, 1901. No. 40452 B.

Ship Propulsion.

Taylor's Analysis Applied to a Screw Ferryboat. Col. E. A. Stevens and Charles P. Paulding. Gives the results of work on the trials of the "Cincinnati." 2800 w. Stevens Ind—April, 1901. No 40368 D.

Ship-Railway.

The Anderson Ship-Railway. Brief illustrated description of a proposed railway invented by Axel B. Anderson of Brooklyn, N. Y., an improvement on the construction proposed by Captain James Eads, in 1883. 800 w. Sci Am Sup—April 13, 1901. No. 40261.

Ship Resistance.

Pressure in Submerged Moving Plates. C. Humphrey Wingfield. Read before the Brit. Inst. of Naval Archts. Instead of considering actual propellers, the more simple case of a plane is taken for the study of the influence of depth of immersion in the distribution of pressure. Ill. 1500 w. Engng—March 29, 1901. No. 40238 A.

Shipyards.

Messrs. Yarrow and Co.'s New Works. Illustrated description of the new works at Poplar. 1100 w. Engng—April 5, 1901. No. 40327 A.

Some Remarks on the Commercial Organization of Shipyards. Walter Scott. Considers the correspondence, estimating, buying, cost, keeping, book-keeping, commercial staff, etc. 4500 w. Naut Gaz—April 18, 1901. No. 40390.

Speed Power Trials.

Speed and Power Trials of Ships. W. F. Durand. A brief discussion of a simple speed or speed power trial, without involving the detailed anaylsis of the general propulsion performance. 2000 w. Sib Jour of Engng—April 1, 1901. No. 40521 C.

Steam Lighter.

Stanch Steam Lighter. Description with illustration, of the "Rocket" being built for the U. S. government. 700 w. Naut Gaz—April 4, 1901. No. 40200.

Steam Turbine.

The Marine Steam Turbine and Its Application to Fast Vessels. C. A. Parsons. Briefly reviews the history of the steam turbine and its application to the propulsion of ships. General discussion. Ill. 8500 w. Trans Inst of Engr & Shipbuilders in Scotland—March, 1901. No. 40555 E.

Steam Yacht.

The Twin-Screw Steam Yacht "Prinzessin Victoria Luise" (Die Doppelschrauben-Dampfyacht "Prinzessin Victoria Luise"). A very complete and well-illustrated description of this fine new vessel of the Hamburg-American line, and of her engines and boilers. 4 plates. 4000 w. Zeitschr d Ver Deutscher Ing—April 6, 1901. No. 40405 D.

Submarine.

Construction and Tests of Submarine Torpedo Boats for the U. S. Navy. Plan showing the chief characteristics of the boats being constructed by the U. S. Navy, with extract from Admiral Hichborn's report, and description of the "Holland" are given in the present article. 2500 w. Marine Engng—April, 1901. Serial. 1st part. No. 40212 C.

Submarine Boats for the British Navy. Sectional drawing of the improved Holland submarine boat, of which five are being built for the British Navy, with comment and description. 2500 w. Engng—March 29, 1901. No. 40236 A.

The Motion of Submarine Boats in the Vertical Plane. William Horgaard. Read before the Brit. Inst. of Naval Archts. An examination of the qualities of stability of motion and manœuvring power, and the manner in which they are affected by varying the rudders, the amount and distribution of buoyancy, shape of hull, etc. 3500 w. Engng—April 5, 1901. Serial. 1st part. No. 40330 A.

The Submarine Boat: Its Promises and Performances. George W. Melville. Reviews the history of submarine boat construction and discusses the merits of such craft. 6000 w. N Am Rev—April, 1901. No. 40121 D.

Topophone.

The Topophone. Illustrates and describes a device for determining the direction of a fog signal at sea, and to enable the sounds to be heard at greater distance. 1100 w. Sci Am—March 30, 1901. No. 40099.

Towboats.

Towing and Towboats. Theodore Lucas. Illustrated description of modern tow-boats and arrangements for towing transportation. 1800 w. Naut Gaz—April 4, 1901. No. 40202.

Vibration.

The Vibration of Steamers. Otto Schlick. Read before the Brit. Inst. of Naval Archts. On some experiments made on board the Atlantic liner "Deutschland," during her trial trip in June, 1900. 6300 w. Engng—March 29, 1901. No. 40242 A.

Wreck.

Loss of the Pacific Mail Steamship City of Rio de Janeiro. A report of the Federal investigation as to the responsibility for this accident which occurred Feb. 22, in San Francisco bay, resulting in the loss of 131 lives and millions in property. 3000 w. Marine Engng—April, 1901. No. 40210 C.

Yachts.

Fifteen Years' Development of the 90-Foot Racing Yacht. A comparison as shown by the "Galatea," the cutter of 1886, and the "Independence," the cutter-sloop of 1901. Ill. 2000 w. Sci Am—April 13, 1901. No. 40259.

The International Racing Yacht "Independence." Particulars, with illustrations, of this cup-defender now under construction. 2000 w. Sci Am—March 30, 1901. No. 40100.

MECHANICAL ENGINEERING

AUTOMOBILISM.

American Vehicles.

The Automobile in America. Brief illustrated descriptions of several heavy vehicles. 2500 w. Auto Jour—April, 1901. No. 40548 A.

The Automobile Industry in the United States. A symposium describing its present condition, with descriptions and illustrations of various types of vehicles, and a brief review of the industry abroad. 11000 w. Elec Rev, N. Y.—April 13, 1901. No. 40284.

Artillery.

A Motor Field Battery. H. A. Bethell. Discusses the advantages and objections to the steam car for military purposes. 4000 w. Auto Jour—April, 1901. No. 40553 A.

Carburettors.

Carburettors. The term as used includes all forms of apparatus for enabling engines to be run with the heavier oils which are not volatile at ordinary atmospheric pressure. Considers their characteristics and peculiarities as compared and contrasted with one another. Also illustrated description of types. 4400 w. Auto Jour—April, 1901. No. 40552 A.

Dawson.

The Dawson Car. Illustrated description. 1000 w. Autocar—April 6, 1901. No. 40314 A.

Economy.

The Prospects for Economical Automobiling. M. C. Krarup. Discusses the outlook, the difficulties involved, etc. 3500 w. Ir Age—April 25, 1901. No. 40533.

Electric Motors.

Selection of Electric Motors. C. E. F. Ahlm. Treats of points in motor design which may be the cause of unusual drain on the battery of an electric vehicle. 1600 w. Horseless Age—April 17, 1901. No. 40342.

Endurance Test.

The Long Island Automobile Club's One Hundred Mile Endurance Test. An account of the run made in very bad weather, with illustrations. 3000 w. Horseless Age—April 24, 1901. No. 40556.

Ignition.

Sparking Troubles. C. H. Guest. From a paper read before the Nottingham (England) Automobile Club. Instruction for users of spark igniters, referring more particularly to jump spark ignition. 4800 w. Horseless Age—April 10, 1901. No. 40267.

The Elements of Electric Ignition for Automotors. General information for those in need of the knowledge, dealing especially with the jump spark system. 3500 w. Auto Jour—April, 1901. No. 40546 A.

Paris Exposition.

The Competition of Automobiles for Industrial Purposes (Compte Rendu des Coucours d'Automobilisme Industriel). M. G. Forestier. A report on the trials of automobiles for cab and omnibus service, trucks and other heavy-weight vehicles, etc., held in connection with the Paris Exposition. Tables and diagrams. 10000 w. Mem d l Soc d Ing Civils—February, 1901. No. 40474 G.

The Competitions of Moto-Cycles, Voiturettes and Touring Automobiles (Compte Rendu des Concours de Motocycles, Voiturettes et Voitures de Tourisme). M. G. Forestier. A report on the trials of the above-named classes of vehicles, held in connection with the Paris Exposition. Tables. 7000 w. Mem d l Soc d Ing Civils—February, 1901. No. 40473 G.

Racing Machines.

Racing Automobiles at the Close of 1900 (La Voiture Automobile de Course à la Fin de 1900). Count G. de Chasseloup-Laubat and M. G. Forestier. A general review of racing automobiles, with accounts of some long-distance races. 6000 w. Mem d l Soc d Ing Civils—February, 1901. No. 40472 G.

Steam Car.

A 12 H. P. Steam Car. A lettered linear elevation and plan of a passenger car in which locomotive practice is followed to the extent of arranging for direct drive upon the cranked driving wheel axle. 1000 w. Auto Car—April 20, 1901. No. 40590 A.

Traction Engines.

The Use of Traction Engines and Armored Trains in the Field. (Emploie des Locomotives Routières et des Trains Blindés en Campagne). G. Espitallier. A discussion of traction engines hauling armored trains across country, with special reference to the experiences of the British army in South Africa. Illustrated. 3000 w. Génie Civil—April 13, 1901. No. 40460 D.

Truck.

The Steam Motor Truck as a Portable Power House. J. G. Dudley. An analysis of the conditions of American service, and of the essential features of the type best adapted to them, with concise statement of conclusions. 4000 w. The Engineering Magazine—May, 1901. No. 40458 B.

War Car.

See Railways and Tramways, Motive Power and Equipment.

Wheel Diameter.

On the Influence of the Diameter of the Wheels on the Power Required for Propelling Automotors. W. A. T. Müller. An attempt to solve the question theoretically. Ill. 2000 w. Auto Jour—April, 1901. Serial. First part. No. 40551 A.

HYDRAULICS.

Pipe Joints.

Pipe Joints for High Pressures. U. Peters. Brief illustrated description of joints adapted for pressures up to 7000 pounds per square inch. 350 w. Am Mach—April 18, 1901. No. 40347.

Pump.

The Schleifmühle Electric Express Pump. J. Divis, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Illustrates and describes a pump designed for use with an electromotor, but which can also be driven by high-speed steam engines. 1000 w. Col Guard—April 12, 1901. No. 40507 A.

Pumping Engines.

Pumping Machinery at Boston and Andover, Mass. (Amerikanische Maschinen und Maschinenanlagen). C. Regenbogen. An illustrated description of the pumping machinery of the Boston Sewerage Works and of the Andover Water Works. 1800 w. Zeitschr d Ver Deutscher Ing—April 13, 1901. No. 40408 D.

Turbine Plant.

Rodney Hunt Turbine Plant at the Great Northern Paper Company's Mill. Illustrated description of this hydraulic plant at Millinocket, Maine, which is the largest of its kind in the world. 1500 w. Sci Am—April 13, 1901. No. 40258.

Turbines.

Turbine Building and Turbo-Electric Stations in Switzerland. Prof. F. Pràsil. A résumé of progress, with particular attention to the installations built since 1888 and the facilities of the largest makers at the present time, and discussion of some of the more important hydro-electric stations. Ill. 3200 w. The Engineering Magazine—May, 1901. Serial, Part I. No. 40457 B.

Water Meter.

See Mechanical Engineering, Steam Engineering.

MACHINE WORKS AND FOUNDRIES.

Boring.

Boring Elliptical Cylinders. Albert E. Guy. Describes a successful method for short cylinders. Ill. 1100 w. Am Mach—April 18, 1901. No. 40348.

Cement Machinery.

Test of Machinery in a Cement Works. Describes tests of the power required to drive kilns, conveyors, crushers, and other machinery in the Krause Cement Works. 1600 w. Eng Rec—April 20, 1901. No. 40356.

Cutting Machine.

A New Elliptical Cutting Machine. C. W. MacCord. Illustrated description of the construction and mode of operation of a machine for cutting elliptical openings. 1400 w. Sci Am Sup—April 6, 1901. No. 40220.

Drilling.

Converting an Old Planer into an Indexing Gang Driller. W. G. Luper. Illustrated description of a machine used for drilling and tapping condenser heads in a western navy yard. 900 w. Am Mach—April 11, 1901. No. 40251.

Foundry Economy.

Foundry Economy. Percy Longmuir. Briefly considers the requirements of econominal castings, economical organization, and economical management. 2600 w. Ir Trd Rev—March 28, 1901. No. 40089.

Foundry Metallurgy.

Foundry Metallurgy. Herbert E. Field. A consideration of the conditions necessary to its success. 3000 w. Mach, N. Y.—April. 1901. No. 40126.

Lathes.

Tool Practice with the Conradson Heavy Turret Lathe. Gives illustrations and descriptions of some of the characteristic tools used on the lathe described in last week's issue. 1300 w. Am Mach—April 25, 1901. No. 40537.

Turret Lathe for Extra Heavy Work. Illustrated detailed description of the latest development in these machines. 1600 w. Am Mach—April 18, 1901. No. 40346.

Machine Tools.

Experiments on the Work of Machine Tools. (Experiences sur le Travail des Machines-Outils). M. Codron. A second part, dealing with cutting tools, of this article on the power consumed by machine tools. Many diagrams and figures. 5000 w. Bull Soc d' Encour—March, 1901. No. 40466 G.

The Mechanical Engineering of Machine Tools. Prof. Charles L. Griffin. A review of the essential principles and very exacting requirements of this branch of mechanical designing, with a concise statement of the requirements of the best practice. 3600 w. The Engineering Magazine—May, 1901. No. 40454 B.

Milling Chuck.

A Special Milling Chuck, and the Making of It. Mike Romitur. Illustrated description. 1600 w. Am Mach—April 4, 1901. No. 40171.

Mixing Iron.

Mixing Iron by Analysis. W. G. Scott. Gives a mixing card showing the number of pounds of coke, flux, scrap and pig iron in each charge, and describes the method of calculating the cupola mixture. 2700 w. Foundry—April, 1901. No. 40135.

Nuts.

Casting Threads in Nuts. Walter Ferris. Illustrates and describes the work, giving results. 1200 w. Am Mach—April 4, 1901. No. 40169.

Screw Machine.

A Magazine Feed for the Automatic Screw Machine. Mike Romitur. Illustrated description of a tool found valuable in the screw-machine department. 800 w. Am Mach—April 11, 1901. No. 40254.

Seamless Pipe.

The Bartlett-Kent Process for Rolling Seamless Pipe. An illustrated detailed description. 2000 w. Ir Age—April 25, 1901. No. 40532.

Shop Management.

Need of Closer Union of Financial and Practical Shop Management. Thomas D. West. A letter briefly stating the writer's opinion of the requirements to fit a young man for the position of manager, superintendent or foreman of a foundry. 2000 w. Ir Trd Rev—March 28, 1901. No. 40090.

Shops.

Machine Shop Practice. D. B. Dixon. Discusses tools and their use, methods of work, etc. 1800 w. Am Mfr—April 11, 1901. No. 40311.

Something About the Warner and Swasey Shops and Work. Illustrated description of shops in Cleveland, for the manufacture of high-grade machine tools, astronomical instruments, etc. 2800 w. Am Mach—April 4, 1901. No. 40168.

The Brown & Sharpe Mfg. Co.'s Works. An illustrated description of the buildings and views of several departments. 3000 w. Mach, N. Y.—April, 1901. No. 40125.

The Works of the Eddy Electric Manufacturing Company. Illustrated description of works for making direct-current apparatus and the methods of manufacture. 1500 w. Elec Rev, N. Y.—April 13, 1901. No. 40283.

Steel Pipe.

A New Method of Manufacturing Steel Pipe. Illustrates and describes the manufacturing methods used in making the pipe for the long pipe line to carry water to Coolgardie, Australia, the important gold mining district. 1400 w. Sci Am—March 30, 1901. No. 40101.

Tools.

A Discussion of Various Boring, Reaming and Facing Tools. James Vose. Illustrates and describes tools and methods. 1200 w. Am Mach—April 4, 1901. No. 40170.

Tool Steel.

See Mining and Metallurgy, Iron and Steel.

MATERIALS OF CONSTRUCTION.

Bronze.

The Strength and Ductility of Bronze in Relation to Temperature. C. Bach, in *Zeitschrift d Ver Deutscher Ing.* A report of experiments giving tables and diagrams. 2800 w. Engr, Lond—April 5, 1901. No. 40332 A.

Steel Axles.

Specifications for Steel Axles Proposed by American Section of International Association for Testing Materials. Comments and discussion by M. H. Wickhorst, engineer of test, C. B. & Q. R. R., Aurora Ill., with communications and general discussion. 7800 w. Pro W Ry Club—March, 1901. No. 40270 C.

POWER AND TRANSMISSION.

Ball Bearings.

Steel Ball Bearings. An illustrated account of the investigations of Prof. Stribeck, on behalf of the German Arms and Ammunition Works of Berlin. An important contribution to the solution of difficult mechanical problems. 4000 w. Engng—April 12, 1901. No. 40510 A.

Cableway.

Shipping Coal by the Aerial Wire Rope System at Port Morien, Cape Breton. Joseph G. S. Hudson. Describes the system installed and its very satisfactory working. 1800 w. Can Min Rev—March 31, 1901. No. 40164 B.

Chains.

Chains and Chain Gearing. Charles Piez. Concerning the use and treatment of chains, with illustrated description of the principle of chain gearing with the ordinary types of chain, design, &c. 3500 w. Pro Engrs' Club of Phila—April, 1901. No. 40528 D.

Compressed Air.

The Location of the Compressed Air Receiver. Frank Richards. At a meeting of the N. Y. R. R. Club it was suggested that the receiver be placed in the warmest place convenient; the writer gives reasons for thinking the reverse would be the best advice. 1000 w. Am Mach—April 25, 1901. No. 40536.

Gearing.

Grisson Gearing. Presents the advantages of a gearing intended for use in cases when the present construction does not answer the requirements, especially in the management of high ratios of transmission. 2000 w. Sci Am Sup—April 20, 1901. No. 40352.

Mechanical Handling.

An Economical Method of Handling Dirt and Ballast. Spencer Miller. Plan views of two rapid unloaders, with comparison of important dimensions showing the difference in the strength of the various parts. 1000 w. R R Gaz—April 19, 1901. No. 40380.

Steam Shovel.

The Thew Steam Shovel; Cleveland, Lorain and Wheeling Ry. Illustrated description of the machine. The chief novelty is in the construction of the swinging boom and the method of manipulating the dipper. 900 w. Eng News—April 11, 1901. No. 40276.

GAS AND OIL ENGINES.

Blast Furnace Gas.

See Gas Engineering.

Diesel Motor.

The Diesel Engine in England. Illustrated description of the English made engine recently exhibited and its operation. Drawings have been prepared for Diesel motors of special design to be used on automobiles of the heavier type. 2200 w. Auto Jour—April, 1901. No. 40547 A.

The Diesel Oil-Engine. An illustrated description of the first Diesel engine made in England, which has several improvements over types made abroad. 2300 w. Elec Engr, Lond—March 29, 1901. No. 40224 A.

The Diesel Oil Engine. Illustrates a British built engine, explaining the mechanical details, and method of working 1800 w. Engng—March 29, 1901. No. 40240 A.

The Diesel Oil Engine. Remarks on the engine recently exhibited at Messrs. Scott & Hodgson's works, England. Ill. 1400 w. Elec Rev, Lond—April 5, 1901. No. 40322 A.

Gas Engines.

Large Gas Engine Practice at Cockerill's Works, Seraing. E. Kilburn Scott. Information concerning large gas engine practice, and observations during a recent visit at these works. 1500 w. Elec Rev, Lond—March 29, 1901. No. 40227 A.

Operating Gas and Gasoline Engines. Harry J. Perkins. The first of a series of articles giving information and advice of service to sellers, buyers and users. 1100 w. Am Mach—March 28, 1901. Serial. First part. No. 40088.

Power Calculations for Gas Engines. Herbert L. Towle. Discusses engine design and the development and use of formulas. 2900 w. Am Mach—April 11, 1901. No. 40253.

The Letombe Gas Engine. An illustrated description of the interesting features of an engine designed to give economy in working and efficiency on the lower loads. Also editorial on its possibilities. 3400 w. Auto Jour—April, 1901. No. 40549 A.

Oil Engines.

Oil Engines in Mining and Milling. A. W. Warwick. Discusses the points needing attention for the economical working of such engines. 4500 w. Min & Sci Pr—March 30, 1901. No. 40167.

STEAM ENGINEERING.

Blowing Engines.

Some Recent Types of Blowing Engines and valves. Illustrated detailed description of the latest developments. 1400 w. Ir & Coal Trds Rev—March 22, 1901. No. 40109 A.

Boilers.

Boilers and Steam Engines at the Paris Exposition. (Les Chaudières et les Machines à l'Exposition de 1900). Ch. Compère. A general review, with details of many of the exhibits. Tables. 2 plates, 18000 w. Mem d l Soc d Ing Civils—January, 1901. No. 40469 G.

Boilers at the Paris Exhibition. Brief illustrated descriptions of exhibits, with comments. 1500 w. Engr, Lond—March 22, 1901. Serial. First part. No. 40113 A.

Boilers at the Paris Exposition. (Die Weltausstellung in Paris, 1900. Die Dampfkessel). Prof. M. F. Gutermuth. A well illustrated general review. Serial. Part I. 1800 w. Zeitschr d Ver Deutscher Ing—March 23, 1901. No. 40402 D.

Steam Boiler Efficiency. William Kent. Abstract of a lecture delivered before the Engng College, Univ of Illinois. Considers the factors of greatest importance. 600 w. R R Gaz—April 19, 1901. No. 40381.

The Belleville Boiler. Editorial discussion of two letters which M. Delaunay Belleville addressed to the secretary of the admiralty. 4000 w. Engng—April 12, 1901. No. 40513 A.

The Montupet Boiler. (La Chaudière Montupet). M. A. Barbet. An illustrated description of a modification of the Field water-tube boiler, remarkable for the simple and efficient manner of fixing the tubes. Tables. 1200 w. Bull Soc d' Encour—March, 1901. No. 40464 G.

The Thornycroft-Marshall Water Tube Boiler. Illustrated detailed description. 1700 w. Prac Engr—April 5, 1901. No. 40285 A.

Water Tube Boilers. W. H. Booth. Discusses the drawbacks which in the writer's opinion condemn these boilers. 1600 w. Am Mach—April 11, 1901. No. 40252.

See Marine and Naval Engineering.

Cooling Towers.

Cooling Towers and the Removal of Oil from Exhaust Steam. A description of a plant reclaiming water in a nearly pure condition, read by F. H. Boyer, before the New England Cotton Mfrs. Assn. 1000 w. Eng Rec—April 27, 1901. No. 40579.

The Klein Water-Cooling Tower. (Réfrigérants à Cheminée, Système Klein). An illustrated description of these cooling towers for condenser water, built entirely of wood. 800 w. Génie Civil—March 23, 1901. No. 40445 D.

Electric Stations.

The Application of Steam Power to the Generation of Electrical Energy. John S. Raworth. Paper read before the Inst of Elec Engs, England, with discussion on the recent development of steam engines due to this use. 4500 w. Elec Rev, Lond—March 22, 1901. No. 40118 A.

Entropy Diagram.

The Study of Steam Engines by Means of the Entropy Diagram. (Etudes des Machines à Vapeur par le Diagramme Entropique). J. Boulvin. A thermodynamic study of the steam engine with many diagrams and a table. Serial. Part I. 5000 w. Rev d Mec—March, 1901. No. 40477 E + F.

Heat Utilisation.

The Utilisation of Heat in the Steam Engine (Die Ziele und die Erfolge in der Wärmeausnutzung bei der Dampfmaschine). W. Lynen. A paper before the Aachen branch of the Ver Deutsch Ing, giving an illustrated and clear exposition of the principles of thermodynamics, steam engineering, cylinder condensation, etc. Serial. Part I. 6000 w. Zeitschr d Ver Deutscher Ing—March 23, 1901. No. 40401 D.

Lubrication.

On the Subject of Lubrication. W. H. Edgar. Concerning cylinder oils, the selection, the conditions and requirements tests, etc. 1700 w. Marine Rev—April 11, 1901. No. 40310.

Moisture.

Calorimeter Trials for Moisture in Steam. Robert W. King. Shows the importance of calorimeter trials and describes methods. Ill. 2300 w. Can Engr—April, 1901. No. 40204.

Pipes.

Losses of Heat from Underground Pipes. Alton D. Adams. Discusses pipe coverings and the methods of calculating losses. 4000 w. Elec Wld and Engr—April 6, 1901. No. 40209.

Outdoor Steam Pipes. William D. Ennis. Considers the best method of supporting, protecting and insulating pipes carried between two detached buildings. Ill. 2000 w. Power—April, 1901. No. 40123.

Scott Engine.

12 Horse-Power "Scott" Cornish Cycle

Engine. Illustrated description of an engine constructed for driving the automatic stokers at the Battersea electric lighting station. 800 w. Engng—March 29, 1901. No. 40241 A.

Steam Engine.

The Steam Engine at the Beginning of the Twentieth Century. (Die Dampfmaschine bei Beginn des 20. Jahrhunderts). Hr. Straube. A paper before the Karlsruhe branch of the Ver. Deutsch Ing., giving a general review of steam engineering. 5000 w. Zeitschr d Ver Deutscher Ing—April 6, 1901. No. 40407 D.

Steam Meter.

The Gehre Steam Meter. Illustrated description of a meter with autographic register, working on the throttling principle. 1000 w. Eng Rec—April 13, 1901. No. 40305.

Superheating.

Superheated Steam. Ernest H. Foster. Read before the junior meeting of the Am Soc of Mech Engs. A statement of the advantages of superheating as a means of increasing the efficiency of steam plants, and a brief description of types of superheaters now in regular use. 4000 w. Eng Rec—April 6, 1901. No. 40178.

Turbines.

Steam Turbine Applications in Europe. Frank C. Perkins. An illustrated account giving information of uses made of the steam turbine at various places, showing its adaptability for certain classes of work. 4000 w. Jour of Elec—March, 1901. No. 40530.

See Marine and Naval Engineering.

Water Meter.

The Rohkohl Feed-Water Meter. (Compteur d'Eau d'Alimentation pour Chaudières, Système Rohkohl). An illustrated description of a simple piston meter for measuring the water supplied to boilers. 700 w. Génie Civil—April 13, 1901. No. 40463 D.

Water Softening.

Water-Softening Plant at Langwith Colliery. J. G. Shearer. Read before the Inst of Min Engs, England. Illustrated description of the process and apparatus by which very hard water was purified. 1200 w. Mines & Min—April, 1901. No. 40182 C.

MISCELLANY.

Aeronautics.

Aeronautics at the Paris Exposition. (L'Aeronautique à l'Exposition de 1900). Com'd't P. Renard. An account of some remarkable balloon ascensions made in connection with the Exposition; and some very good photographs taken from balloons. 1600 w. Bull Soc d'Encour—March, 1901. No. 40465 G.

Recent Progress in Aerial Navigation. Charles H. Cochrane. Reviews and illustrates attempts at aerial navigation, especially those not well-known. 1500 w. Pop Sci M—April, 1901. No. 40103 C.

The Termination of the Trials of Count Von Zeppelin's Air-Ship. H. W. L. Moedebeck. Describes the technical improvements and the second and third trials, which have demonstrated that it will be possible to navigate the air. 2000 w. Sci Am Sup—April 13, 1901. No. 40260.

The Zeppelin Air-Ship (Das Graf Zeppelin'sche Luftschiff). St. Col. Buchholtz. An illustrated description of the Zeppelin air-ship and some of its predecessors, with an account of the Zeppelin trials in the summer of 1900. 4000 w. Glasers Ann—April 1, 1901. No. 40413 D.

The Zeppelin Air-Ship (Das Zeppelin'sche Ballonproblem). Captain Hermann Hoernes. A well illustrated and complete account of this large air-ship, its construction and its three flights above the Lake of Constance. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—March 22, 29, 1901. No. 40435 each B.

Artillery.

Our New German Field Artillery Guns. Concerning the guns manufactured in Germany for the use of the British field artillery, describing the gun and carriage. 1500 w. Engr, Lond—March 22, 1901. No. 40112 A.

Bibliography.

Industrial Bibliography. (La Bibliographie Industrielle). Jules Garçon. An article calling attention to the necessity for indexes, dictionaries and bibliographies in industrial and scientific work, with a notice of some of the technical catalogues and dictionaries. 4000 w. Bull Soc d'Encour—March, 1901. No. 40467 G.

Bicycles.

The Resistance and Efficiency of Bicycles on Roads (Das Fahrrad im Strassenbaudienste mit Besonderer Berücksichtigung der Oekonomie von Kraft und Zeit). R. Iszkowski. A full discussion of the resistance and operation of bicycles at various speeds and on various grades on different kinds of roads and streets. Tables. Serial. Part I. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—April 6, 1901. No. 40440 D.

Cost Keeping.

The Principles of Cost Accounting. F. A. Halsey. A discussion of cost systems, the importance and object. 8000 w. Sib Jour of Engng—April, 1901. No. 40519 C.

Education.

Instruction in Foundry Practice at the University of Illinois. D. T. Randall. Illustrated description of the shops, appliances and instruction given. 1000 w. Jour

Am Found's Assn—April, 1901. No. 40133.

The Education of Mechanical Engineers and Chemists in the Higher Technical Schools of Russia. (Die Ausbildung der Maschineningenieure und Chemiker in den Höheren Technischen Lehranstalten Russlands). M. Sserebroffsky and G. v. Doepp. A general account of the Russian technical schools and their curricula. 4000 w. Zeitschr d Ver Deutscher Ing—April 6, 1901. No. 40406 D.

Evaporator.

Tests of Quiggin Evaporators, in Single, Double and Triple Effect. W. Everett Parsons. An account of tests made to determine the economy of producing distilled water for ice-making purposes. 2200 w. Stevens' Ind—April, 1901. No. 40370 D.

Glasgow Exhibition.

Scope and Significance of the Glasgow International Exhibition. Benj. Taylor. Summarizes the purposes, outlines the buildings and arrangement, and gives a synopsis of the power plant and electrical equipment. Ill. 3200 w. The Engineering Magazine—May, 1901. No. 40453 B.

Heating.

A Hot-Blast Furnace Heating Installation. Illustrated description of apparatus for heating a public hall by blowing air through hot-air furnaces. 600 w. Eng Rec—April 20, 1901. No. 40364.

Metric Screw Thread.

International Metric Screw-Thread System. (Internationales Gewindesystem auf Metrischer Grundlage). A description, with diagram and table of the system adopted by the Ver. Deutsch. Ing., the Société d'Encouragement pour l'Ind. Nat. and the Ver. Schweiz. Masch. Industrieller at Zürich, Oct., 1900. 800 w. Zeitschr d Oesterr Ing u Arch Ver—April 12, 1901. No. 40437 B.

Nineteenth Century.

Progress and Tendency of Mechanical Engineering in the Nineteenth Century. Robert H. Thurston. An address before the Washington Acad. of Sciences, Columbian University. 4300 w. Pop Sci M—May, 1901. Serial. First part. No. 40576 C.

Paris Exposition.

The Mechanical Installation at the Paris Exposition (Installations Générales du Service Mécanique de l'Exposition Universelle et Internationale de 1900). Charles Bourdon. A complete account of the organization of the mechanical service, the power plant, the distribution of water, etc., ventilation, etc. Two plates. 13000 w. Mem d l Soc d Ing Civils—January, 1901. No. 40468 G.

Plenum System.

A Plenum Fan System of Heating in an Exposition Building. Illustrated description of the forced blast system of the New York State Building at the Pan-American Exposition. The building is a permanent structure and the plant is designed to keep the temperature at 70 degrees with the outside air 10 degrees below zero, and to change the air every 10, 15 or 20 minutes, according to the nature of the occupancy. 1600 w. Eng Rec—April 13, 1901. No. 40306.

Refrigeration.

Refrigerating Machines at the Paris Exposition. (Die Weltausstellung in Paris, 1900. Die Kältemaschinen). R. Schöttler. An illustrated general review, with particular descriptions of various details. 2500 w. Zeitschr d Ver Deutscher Ing—March 23, 1901. No. 40400 D.

Sugar Plant.

The Beet Sugar Plant at Fremont, O. Illustrated description of plant with new apparatus for rapid crystallization of low products and new forms of centrifugals, with notes on a method of utilizing the poor molasses now run to waste. 900 w. Eng Rec—April 13, 1901. No. 40303.

Ventilation.

Improvements in the Ventilation of the Law Courts. An outline of the improvements made including the adoption of the Davidson "Sirocco" fans. 1500 w. Engr. Lond—April 12, 1901. No. 40517 A.

Ventilating and Heating a Restaurant. Illustrated description of a plant in which fresh air is forced through direct radiators to ventilate a restaurant in the basement of a large office building. 900 w. Eng Rec—April 27, 1901. No. 40585.

MINING AND METALLURGY

COAL AND COKE.

British Columbia.

The Coal Creek Colliery of the Crow's Nest Pass Coal Co. C. V. Corless. Read before the Canadian Min. Inst. Illustrated description of the mines and their working, production, etc. 5500 w. Can Min Rev—March 31, 1901. No. 40166 B.

Coke Ovens.

Improved Heminway Process of Coking Coal in Beehive Coke Ovens. R. S. Moss. Illustrates and describes the process as used at the plant of the Universal

Fuel Co., Chicago, Ill. 3400 w. Mines & Min—April, 1901. No. 40187 C.

The New Coke Plant of the Eureka Fuel Company in the Klondike Region, Pennsylvania. J. P. Brennen. Illustrates and describes a complete modern plant. 2300 w. Mines & Min—April, 1901. No. 40180 C.

See Gas Engineering.

Fans.

Rope Driven versus Direct Driven, Colliery Ventilating Fans. Francis T. Peacock. On the conditions which should determine a selection of the type to be used, and the advantages of each. 2400 w. Can Min Rev—March 31, 1901. No. 40165 B.

France.

Coal, Iron and Steel Production of France. Statistics giving an estimate of the coal, lignite, iron, and steel produced in France during 1899 and 1900. 600 w. U S Con Repts, No. 1021—April 26, 1901. No. 40545 D.

Geology.

The Permo-Carboniferous Boundary and What We Learn About It from the Sealand and Thurgarton Boreholes. W. J. Clarke. Abstract of a paper read before the Chester Soc. of Nat. Science. On means of determining the dividing line between the permian and carboniferous formations. 1500 w. Col Guard—April 4, 1901. No. 40335 A.

Nova Scotia.

Coal Mining in Nova Scotia. Concerning the production and new developments. 800 w. Eng & Min Jour—April 20, 1901. No. 40372.

Pennsylvania.

The Coal-Field of Somerset County, Pa. W. G. Irwin. Information concerning the most important mines, and the transportation facilities. 1100 w. Eng & Min Jour —April 27, 1901. No. 40591.

Spontaneous Ignition.

Storage and Spontaneous Ignition of Coal. Herr Sohren. Abstract of a paper read before the German Gas Assn. Discusses the subject of spontaneous ignition, reviewing the early investigations and recent work, and giving Dr. Munk's recommendations. 1700 w. Gas Wld—April 13, 1901. No. 40500 A.

United States.

Growth of the Coal Industry in the United States. From a report issued by the United States Government; giving a review of the progress, the geographical distribution, and related information. 5000 w. Col Guard—March 22, 1901. No. 40115 A.

Vancouver.

The Vancouver Coal Mines. An account of quite a number of changes in the mines of Vancouver Island during the past year. 1000 w. U S Cons Repts. No. 1020—April 25, 1901. No. 40526 D.

COPPER.

Lake Superior.

Early Copper Days of Lake Superior. Graham Pope. Read before the Lake Superior Min. Inst. Interesting historical review of the copper mining industry in this region. 6000 w. Marine Rev—March 28, 1901. No. 40092.

The Lake Copper Industry. H. J. Stevens. How it has expanded within a few years by the opening of new mines and the equipment of new mills. 2200 w. Mines & Min—April 1901. No. 40185 C.

Smelting.

The History of Copper Smelting in the Lake Superior Region. James B. Cooper. Abstract of a paper read before the Lake Superior Min. Inst., reviewing this industry. 1100 w. Eng & Min Jour—April 27, 1901. No. 40592.

Southern United States.

Valuable Opportunities in Southern Copper. C. F. Z. Caracristi. A review of this region showing at least three copper deposits of proved value, and copper in greater or less quantity in all Southern States. Gives information to investors. Ill. 7000 w. Mfrs Rec—April 18, 1901. No. 40341.

GOLD AND SILVER.

Australia.

Gold Mining and Milling in Western Australia. A. G. Charleton. This fourth paper of the series deals with mining methods, extent and rate of development, costs, and special conditions encountered. Ill. 6300 w. The Engineering Magazine—May, 1901. No. 40455 B.

British Columbia.

The North Star Mine and Nickel Plate Mine of British Columbia. J. M. Turnbull. Read before the Applied Science Soc of McGill Univ. Details of the operation of these silver mines. 4000 w. Can Engr—April, 1901. No. 40295.

Colorado.

The Liberty Bell Mine. A description of the mine, gold and silver ores, difficulties in successfully treating them, methods of transportation, etc. Ill. 2000 w. Mines & Min—April, 1901. No. 40186 C.

Dredging.

Dredging Fine Gold. Fred. Shury. Explains how the mixing-tank system can be successfully worked in dredging beach gold. Ill. 1700 w. N Z Mines Rec—Feb. 16, 1901. No. 40292 B.

Gold Dredging. F. C. Nettleton. Discusses the things which should be considered in installing a plant, some of the difficulties and how they may be met. 2000 w. Mines & Min—April, 1901. No. 40189 C.

Leaching.

Modern Leaching Processes. J. Ohly. Describes various leaching processes due to the variety of ores to be treated. 2300 w. Min & Sci Pr—April 6, 1901. No. 40266.

Mispickel.

The Treatment of Auriferous Mispickel ores at Deloro, Ontario. Two papers read before the Canadian Min Inst. One by P. Kirkegaard, the other by Sydney B. Wright. Concerning the mining, milling and particulars of treatment. 7500 w. Can Min Rev—March 31, 1901. No. 40163 B.

Permanganate Process.

Prof. Black's Permanganate Process. Dr. H. Norman. A description of the important phases of this discovery, and a statement of its chief points of advantage over the chlorination process. 3000 w. Min & Sci Pr—April 6, 1901. No. 40265.

IRON AND STEEL.

Armor Plate.

Armor Plate at the Paris Exposition. (Les Blindages à l'Exposition de 1900). L. Baclé. A comprehensive review of armor plate as shown at the Exposition, with detailed accounts of some of the plates. Serial. Part I. 4500 w. Génie Civil—April 13, 1901. No. 40462 D.

Australasia.

Iron Making in Australasia. Information concerning the supply in New South Wales, Victoria, New Zealand, Tasmania and South Australia. 2800 w. Ir & Coal Trds Rev—April 12, 1901. No. 40508 A.

Cannon Steel.

Official Testing of Steel for Cannon in France and in the United States. (Essais Officiels de Réception des Aciers à Canon en France et aux Etats-Unis). M. S. Heryngfet. Description of methods of testing, with results of tests. Tables. 5000 w. Mem d l Soc d Ing Civils—February, 1901. No. 40471 G.

France.

See Mining and Metallurgy, Coal and Coke.

Pig Iron.

The Sampling and Grading of Pig Iron. Herbert E. Field. Describes method and shows its accuracy. 1500 w. Found—April, 1901. No. 40136.

Spain.

Development of Iron Ore Mining and its Manufacture in the Central Portion of the north of Spain. John Alcock Jones. A review of the provinces of Lugo, and Leon, and the principality of Asturias. Maps. 2400 w. Ir & Coal Trds Rev—April 5, 1901. Serial. 1st part. No. 40336 A.

Steel Industry.

Britain and Her Competitors in Iron and Steel Making. E. Phillips. A comprehensive review of contrasting physical and economic conditions in Britain and America, with summary of their nett influence on the cost of steel making. Serial. 1st part. 6500 w. Engineering Magazine—May, 1901. No. 40451 B.

Steel Works.

The Steel-Works, Wire-Works and Sheet Mills of Dorman, Long & Co., Middlesborough. An illustrated account of important English works. 3200 w. Ir & Coal Trds Rev—April 5, 1901. No 40337 A.

Tool Steel.

Tool Steel (Rundschau). A review of the Taylor-White tool steel, made at Bethlehem, Pa., and explanation of the way the cutting tool retains its sharpness, and a table comparing the operation of tools made of this steel with those of other steels. 1800 w. Zeitschr d Ver Deutscher Ing—March 30, 1901. No. 40404 D.

MINING.

China.

Prospecting in China. Auguste Mathez. Describes the country north of Peking, and its inhabitants. Ill. 2700 w. Mines & Min—April, 1901. No. 40183 C.

Compressed Air.

Compressed Air in Mining. J. E. Bell, in *Mining and Metallurgy*. On the cost of compressed air per indicated horse-power, claiming that a large air-compressing plant could be made with a conservative estimate of 75 per cent. of the cost of an electric plant of a like size. 4800 w. Compressed Air—April, 1901. No. 40232.

Colorado.

Mining in Colorado. H. A. Lee. Epitome of report of the State Bureau of Mines, Colorado, 1899-1900. 1800 w. Mines & Min—April, 1901. No. 40188 C.

Electric Blasting.

Electric Shot-Firing in Quarries. Gives some reasons for adopting it. 2800 w. Quarry—April, 1901. No. 40589 A.

Oil Engines.

See Mechanical Engineering, Gas and Oil Engines.

Philippines.

The Uses of Native Woods in Mining in the Philippines. Describes improvements in rope-haulage, introduced in the mines newly equipped by foreign capitalists, the wheels being constructed of "bullet" wood of the islands. Also other uses to which the wood is adapted, and information concerning the native workmen and their methods. Ill. 1700 w. Eng & Min Jour—April 6, 1901. No. 40214.

Safety Lamps.

Miners' Electrical Safety Lamps. Sydney F. Walker. Read before the Inst. of Elec. Engs., England. Gives particulars of a number of attempts at producing a safety lamp to meet the needs of miners, discusses the difficulties, and the advantages a reliable electric lamp would possess. 3500 w. Ir & Coal Trds Rev—March 29, 1901. Serial. 1st part. No. 40247 A.

Scotland.

Mining Practice in Scotland. David Rankin. Read before the Glasgow Assn. of students. Considers the letting of mineral fields, proving, fitting, working, surveying, checking rental returns, valuing of minerals and of works and accessories as related to the duties of the mining engineer. 3000 w. Col Guard. March 29, 1901. No. 40263 A.

Shaft Sinking.

Sinking No. 5 Shaft at the Tamarack Mine, Michigan. William E. Parnall, Jr. Read before the Lake Superior Min. Inst. Illustrates and describes the work of sinking a shaft 4,684 feet deep, which occupied 4½ years. 3000 w. Eng & Min. Jour—April 13, 1901. No. 40308.

Steel Construction.

Steel Construction for Mines. From an address by Mr. Jackson, at a meeting of mine managers in Ishpeming, on the use of steel instead of wood in buildings, shafts, &c. 3600 w. Marine Rev—April 4, 1901. No. 40199.

Timbering.

Methods of Preventing Falls of Roof Adopted at the Courrières Collieres. Report of a committee sent to investigate the special methods adopted in these French collieries which have resulted there in a remarkable diminution of the number of accidents. Ill. 9000 w. Col Guard—March 22, 1901. No. 40114 A.

Tunnel.

See Civil Engineering, Construction.

MISCELLANY.

Aluminum.

The Progress of Aluminum. The first of a series of articles on the headway made by this metal during the last year. 2200 w. Engr, Lond—March 22, 1901. Serial. 1st part. No. 40110 A.

Bismuth.

Bismuth Assay. A. W. Warwick and T. D. Kyle. Discusses the inaccuracies of the usual methods of assaying bismuth, and recommends a modification of the process devised by Pattison Univ. 1300 w. Eng & Min Jour—April 13, 1901. No. 40307.

Briquetting.

The Briquetting of Pulverulent Ores (Agglomération des Minerais Pulvérulents). A. Lapanche. An illustrated description of methods of forming finely divided ore into briquettes for convenience in metallurgical treatment. 1 Plate. 2200 w. Génie Civil—April 13, 1901. No. 40451 D.

Geology.

Peculiar Geological Formations of the Southern States. Arthur Lakes. Considers the circumstances which cause them, and their relation to vein formation and mining. 1600 w. Mines & Min—April 1, 1901. No. 40190 C.

Petroleum.

Significance of the Texas Oil Field. An account of this wonderful discovery, the enormous production, its convenient location for transportation, the character of the oil, other fields, etc. 8300 w. Mfrs' Rec—April 11, 1901. No. 40268.

The Oil-Fields of Baku. G. Frederick Wright in *The Nation.* Information concerning these fields near the Caspian Sea, the extent, production, transportation, facilities, etc. 1400 w. Sci Am Sup—April 6, 1901. No. 40218.

The Russian Petroleum Trade. On the production of crude oil at the Baku fields, the price at the wells, refining, consumption, transportation, etc. 7700 w. U. S. Cons Repts. No. 1002—April 4, 1901. No. 40156 D.

Philippines.

The Unexplored Mineral Resources of the Philippines. Frank L. Strong. An interesting explanation of the illusory and unreliable character of the Spanish data and surveys and of the scantiness of exact information, with a general statement of the resources, so far as actually known. 1800 w. The Engineering Magazine—May, 1901. No. 40456 B.

Salting.

Salting of Ore Samples. An account of a sensational case in Australia. 4800 w. Aust Min Stand—Feb. 28, 1901. No. 40296 B.

Turquoise.

The Turquoise Mines of the Cerrillos Mountains in New Mexico. Arthur Lakes. Describes these mines which are said to be the largest producers in the world. 1400 w. Mines & Min—April, 1901. No. 40184 C.

Zinc.

The Zinc Problem at Georgetown, Colo. On the treatment of zinc blende, and other zinc ores. 700 w. Min Rept—April 18, 1901. No. 40384.

Zinc-Lead.

The Zinc-Lead Deposits of Southwest Arkansas. William B. Phillips. Describes these mines and the work already accomplished. 1400 w. Eng & Min Jour—April 6, 1901. No. 40213.

RAILWAYS AND TRAMWAYS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in February. Detailed list and classified summary. 3900 w. R R Gaz—April 5, 1901. No. 40203.

Road Material.

Electric Railways for the Transportation of Road Material. A statement, by F. P. Cobb, of the advantages of hauling road materials on street railways and permitting cars so loaded to run on the tracks of more than one company. 1000 w. Eng Rec—April 27, 1901. No. 40587.

Rules.

Report of Committee on Interchange Rules. Gives the report of the committee and its discussion. 8000 w. Cent Ry Club—March, 1901. No. 40160 C.

Train Sheets.

The Use of the Train Diagram in Determining the Best Location of Power-House and Sub-Stations for Interurban Railways. Edward P. Roberts. An outline of the more usual factors to be considered in connection with the design of an interurban electric road, indicating something of the value of a train sheet. 5500 w. Stevens Ind—April, 1901. No 40366 D.

Trolley.

The Trolley Age. Albert L. Johnson, in *The Independent.* Considers the electric system of transportation will make it possible to greatly reduce rates and give rapid service. 1500 w. Sci Am Sup—April 27, 1901. No. 40542.

FINANCIAL.

French Tramways.

The Economy of Electric Traction in France (Résultats Economiques de la Substitution de la Traction Electrique à la Traction Animale). Charles Jean. An article with many tables showing statistics and financial results of the substitution of electric for animal traction in six French cities. 3000 w. Génie Civil—March 30, 1901. No. 40447 D.

Railroad Taxation.

What Is the Value of a Railroad for Purposes of Taxation? Charles Hansel. A discussion of the work of Prof. M. E. Cooley, who was selected to examine and report on the railroad properties of the State of Michigan, and the subject in general. 2500 w. R R Gaz—April 19, 1901. No. 40383.

MOTIVE POWER AND EQUIPMENT.

Accumulator Car.

The Use of Accumulator Cars on Standard Railways (Verwendung von Akkumulatoren für den Omnibusbetrieb auf Hauptbahnen). Hr. Gayer. A paper before the Verein für Eisenbahnkunde, giving an illustrated account of the operation of accumulator cars in local service about Ludwigshafen, Worms and Neustadt, Germany, with diagrams. 3 plates. 5000 w. Glasers Ann—March 15, 1901. No. 40412 D.

Air Brakes.

Air-Brake Efficiency. Continued discussion of this subject. 15300 w. Cent Ry Club—March, 1901. No. 40159 C.

Armored Train.

See Mechanical Engineering, Automobilism.

Berlin.

The Electric Operation of the Berlin "Ringbahn" (Der Elektrische Betrieb auf der Berliner Stadt und Ringbahn). Hr. Schimpff and Prof. Kübler. A discussion of the substitution of electricity for steam on the city railway of Berlin. The subject is considered from every side and electrical operation is strongly recommended. 5000 w. Glasers Ann—April 1, 1901. No. 40414 D.

Box Cars.

40-Ton Box Cars with Steel Underframes. Illustrates and describes cars for the Union Pacific R. R. 300 w. Am Engr & R R Jour—April, 1901. No. 40142 C.

60,000-lb. Capacity Box Car with Pressed Steel Underframe—Philadelphia & Reading Railroad. Description, photograph and line drawings. 1100 w. R R Gaz—March 29, 1901. No. 40095.

Brake.

Hydraulic Electric-Car Brake. Illustrated description of what is known as the Neal-Duplex brake, which is operated on the hydraulic principle. 800 w. Sci Am—April 6, 1901. No. 40217.

Car Framing.

A System of Steel Framing for Freight Cars. G. W. Scott. Illustrated description of a system of underframing and a discussion of the requirements fundamental in car design. General discussion follows. 10500 w. Pro W Ry Club—March, 1901. No. 40269 C.

Compressed Air.

I. Railroad Uses of Pneumatic Tools. Ill. Thomas Aldcorn. II. Compressed Air in Railroad Service. W. P. Pressinger. Two papers, discussed together, on the uses for compressed air in railroad work. 12800 w. N Y R R Club—March 21, 1901. No. 40281.

Connecticut.

Some Wrinkles on the Fair Haven & Westville Railroad. Illustrated description of the tower car, motor testing device and pit jack and rack. 900 w. St Ry Jour—April 6, 1901. No. 40196 D.

Dining Car.

A Modern Dining Car—C. B. & Q. Railway. Illustrated description of new cars possessing novel features. 600 w. Ry Mas Mech—April, 1901. No. 40139.

Draft Gears.

Road Tests of Draft Gears. A report of tests made on the Chicago division of the Atchison, Topeka and Santa Fe Railway. 1000 w. Am Engr & R R Jour—April, 1901. No. 40146 C.

The Atchison Draft-Gear Tests. H. H. Westinghouse. A letter disagreeing with the conclusions editorially expressed concerning the results of these tests. 1100 w. R R Gaz—April 19, 1901. No. 40379.

Electric Locomotives.

Electric Mine Locomotives. W. B. Clarke. Things to be observed in the choosing, operating and caring for mine locomotives to ensure the greatest economy. Ill. 3600 w. Mines & Min—April, 1901. No. 40181 C.

Electro-Magnetic Tramway.

Electric Traction Independent of Adhesion (Traction Electrique Indépendante de l'Adhérence). F. D. A brief, illustrated description of a polyphase system of traction on the principle of a "travelling magnetic field," in which the car carries what corresponds to the "rotor" and the sectional "stator" is disposed along the line. The car is then pulled along by the attraction of the moving magnetic field. 500 w. Génie Civil—April 6, 1901. No. 40459 D.

Furniture Car.

50-Ft. Furniture Car with Steel Underframing—Erie Railroad. Illustrates and describes cars of 60,000 lbs. capacity, of interest because of its dimensions and composite structure. 1000 w. R R Gaz—April 26, 1901. No. 40572.

Grates.

Large and Small Grate Areas and Combustion. A. Bement. Discusses the advantages of frequent, light firing and shaking of grates, studied by gas analysis. 2000 w. Am Engr & R R Jour—April, 1901. No. 40143 C.

Locomotives.

A Creusot High-Speed Locomotive. From *La Nature*. Illustrated description of engine constructed after plans of M. Henri Thuile built with the object of attaining speeds of 72 miles and commercial speeds of about 60 miles for the hauling of 200 tons. 600 w. Sci Am Sup—April 13, 1901. No. 40262.

American Locomotives for South Africa. Brief illustrated description of ten-wheel passenger engines for the Cape Government Ry's of Cape Colony. 300 w. Eng News—April 25, 1901. No. 40562.

An Engine Built in 1832. Herbert T. Walker. A drawing of the engine "Pioneer," with information concerning it. 1200 w. R R Gaz—April 12, 1901. No. 40273.

Austro-Hungarian Compound Locomotives at the Paris Exposition (Les Locomotives à l'Exposition de 1900: Locomotives Compound de la Société Austro-Hongroise des Chemins de Fer de l'Etat). F. Barbier. An illustrated description of some ten-wheel, compound locomotives. 1000 w. Génie Civil—April 6, 1901. No. 40449 D.

British Locomotives in 1900—Designs and Work. Charles Rous Marten. From the Bulletin of the International Ry. Cong. 2000 w. R R Gaz—April 26, 1901. No. 40574.

"Chautauqua" Type Passenger Locomotive. Illustrated description of a fast locomotive built for the Chicago, Rock Island, and Pacific Ry. 1500 w. Am Engr & R R Jour—April, 1901. No. 40141 C.

Express Locomotive: Krauss System. Illustrated description of an engine exhibited at the Paris Exhibition. A twelve-wheeled express engine, of which four wheels were coupled. It was fitted with auxiliary motor wheels (system Krauss), and had a truck at each end. 1100 w. Engng—April 12, 1901. No. 40511 A.

Express Passenger Engine, Great Central Railway. Illustrated description of a single-wheeled bogie engine with tender designed for service on the new London extension line. 1500 w. Engr, Lond —April 12, 1901. No. 40518 A.

Express Passenger Engine, Mediterranean Railway of Italy. Illustrated detailed description of an engine exhibited at Vincennes. 1600 w. Engr, Lond—April 5, 1901. No. 40333 A.

Locomotives at the Paris Exposition (Les Locomotives à l'Exposition de 1900). F. Barbier. A well-illustrated description of a high-speed, ten-wheel, compound locomotive, built by the Chemnitz (Saxony) works. 1 plate. 2000 w. Génie Civil—March 23, 1900. No. 40-444 D.

Mogul Fast Freight Locomotives. Illustrated description of simple and compound engines with wide fireboxes, for the Atchison, Topeka & Santa Fe Ry. 450 w. Am Engr & R R Jour—April, 1901. No. 40145 C.

New Passenger Locomotives for the Lake Shore & Michigan Southern. Illustrated description of new wide fire-box locomotives. 800 w. R R Gaz—March 29, 1901. No. 40096.

Tests of Wide and Narrow Fire-Box Locomotives. Gives results of road tests, burning soft coal, which furnish the most recent and thorough facts concerning wider grates. Also editorial. 3700 w. R R Gaz—March 29, 1901. No. 40094.

The Locomotive of the Future—A Suggestion. Discusses the advisability of removing the engines and driving-wheels to the tender. 1100 w. Sci Am—April 27, 1901. No. 40539.

Two New Schenectady Consolidation Locomotives. Illustrates and describes two engines for freight service, one on the Southern Pacific, the other on the Boston & Maine R. R. 1800 w. Ry & Engng Rev—March 30, 1901. No. 40154.

Wide Fire-Box Passenger Locomotives for the Chicago, Rock Island & Pacific Railway. Illustrated description, with general dimensions of a locomotive for burning bituminous coal. 700 w. R R Gaz—April 26, 1901. No. 40570.

Locomotive Building.

Locomotive Building in the United States. John H. Converse. An account of the development of this industry, taken from a statement made to the Industrial Commission. 2700 w. Ir Age—April 4, 1901. No. 40155.

Motors.

The Service Capacity of Railway Motors. A. H. Armstrong. Considers method of predetermining the fitness of a railway motor for a given service. 4000 w. St Ry Jour—April 6, 1901. No. 40-198 D.

Motor Construction.

The Construction of an Electric Tramway Motor. S. H. Short. Illustrates and describes the various processes through which the steel, iron and copper must go to make a complete modern motor. 1100 w. Elec Rev, Lond—March 29, 1901. Serial. 1st part. No. 40228 A.

Motor Tests.

Comparative Tests of Street Railway Motors. C. H. Bigelow. Read at Boston meeting of the New England St. Ry. Club. A report of comparative tests between four-motor and two-motor cars. 1600 w. Elec, N. Y.—April 10, 1901. No. 40255.

Ore Car.

Improved Ore Car, 100,000 Pounds Capacity. Illustrated description of a hopper ore car for the Chicago, Milwaukee and St. Paul Railway. 450 w. Am Engr & R R Jour—April, 1901. No. 40147 C.

Packing.

Best Method of Preparing Journal Box Packing. J. W. Bunn. Illustrated description of vats for treating packing. 900 w. Ry Mas Mech—April, 1901. No. 40140.

Steel Car.

Special Steel Car, Northern Ry. of France. Illustrated description of a special design of freight car equipment for the transportation of heavy machinery. 800 w. Ry & Engng Rev—April 20, 1901. No. 40386.

Throttle-Valves.

The Design of Locomotive Throttle Valves. A discussion of a "compensating" throttle-valve, invented by J. S. Chambers. 1900 w. Eng News—April 25, 1901. No. 40566.

Train de Luxe.

A Train de Luxe for Rhodesia. Illustrated description of a magnificent train for first-class passenger traffic. 700 w. Transport—April 12, 1901. No. 40398 A.

Train Lighting.

Train Lighting by Electricity. George D. Shepardson. Briefly reviews the history of train lighting and the advantages of electric lights, and notes the various plans that have been tried. Ill. 7400 w. St. Louis Ry Club—March 8, 1901. No. 40134.

Tramcars.

Tramcar Construction. Illustrated description of the work taken from an interesting pamphlet issued by a British firm. 2200 w. Elec Engr, Lond—March 22, 1901. No. 40116 A.

War Car.

The Simms 6-H. P. Petrol Motor and War Car. Illustrates and describes a car built to run upon the permanent ways of any railroad system, intended for making inspections or sending despatches, and for the protection of the railway generally. 1000 w. Auto Jour—April 1901. No. 40550 A.

NEW PROJECTS.

California--Utah.

Railroads Between Los Angeles and Salt Lake City. An account of two lines claiming the same right of way, giving an outline of the history of the contest. 1200 w. R R Gaz—April 26, 1901. No. 40575.

Interurban.

Interurban Electric Railroad Development in Northern Ohio. An account of the connecting of detached systems forming interurban lines and, ultimately, extended trunk lines between large centers, and the problems in consequence. 1500 w. R R Gaz—April 26, 1901. No. 40573.

Trans-Siberian.

Review of Progress on the Trans-Siberian. L. Lodian. Illustrated notes taken on a 366-day inspection tour. 3000 w. Loc Engng—April, 1901. Serial. 1st part. No. 40128 C.

PERMANENT WAY AND FIXTURES.

Albany Improvements.

New York Central Improvements at West Albany. Illustrations giving a general idea and some details of the new yards, round-houses and accessories, a coal stocking plant, and a coal trestle, on the N. Y. C. & H. R. R. R. 900 w. R R Gaz—March 29, 1901. No. 40093.

British Guiana.

The New Electric Railway at Georgetown, British Guiana. Brief description of the city and the conditions to be met, with an account of the construction and equipment of the line. 2000 w. St Ry Jour—April 6, 1901. No. 40197 D.

Brooklyn Bridge.

The Brooklyn Bridge Terminal Problem. Editorial discussion of the plans proposed in 1888 by A. M. Wellington, the changed conditions since then, and some suggestions suited to the present problem. 3000 w. Eng News—April 11. 1901. No. 40279.

Conduit Tramway.

An Electric Tramway with Side Conduits (Tramway Electrique à Caniveau Latéral). Henry Martin. A well illustrated description of a Paris tramway, with the conduit under one of the rails, running from the Bastille to St. Ouen. 1 plate. 3000 w. Génie Civil—April 6, 1901. No. 40448 D.

Crossings.

Crossings of Steam and Electric Railways. Report of the Am. Ry. Engng. and Main. of Way Assn., relating to the safety of highway surface crossings of railways. 1800 w. St Ry Rev—April 15, 1901. No. 40388 C.

Cuts.

Some Ideas on Side-Hill Cuts. Henry W. Allen. Points of information on cuttings for roadbed in side-hills. Ill. 900 w. Ry & Engng Rev—April 13. 1901. No. 40201.

Indiana.

See Electrical Engineering, Generating Stations.

Liverpool.

The Street Railway System of Liverpool, England. Illustrated description of the tramway scheme, the power plants also supplying energy for electric lighting. 6700 w. St Ry Jour—April 6, 1901. No. 40192 D.

Michigan.

The System of the Michigan Traction Company and the Power House of the Kalamazoo Valley Electric Traction Company. Brief illustrated description. 1500 w. St Ry Jour—April 6, 1901. No. 40194 D.

Naples.

The Street Railway System of Naples. Cesare Pio. Brief illustrated account of the electrical equipment of the street railway lines. 1400 w. St Ry Jour—April 6. 1901. No. 140193 D.

Rails.

A Criticism of the Report of the Board of Trade Committee on Steel Rails. John Oliver Arnold. Abstract of a lecture delivered before the Sheffield Soc. of Engs. and Met. Ill. 1700 w. Ir & Coal Trds Rev—April 12, 1901. No. 40509 A.

Seattle.

Notes on Seattle Street Railway Practice. Illustrates and describes the soldered bonds used, the block signals, snow drags, bracket construction, etc. and gives information concerning the operation. 2400 w. St Ry Jour—April 6, 1901. No. 40195 D.

Shops.

Bloomington Shop Improvements. Illustrated description of improvements on the Chicago & Alton Railroad. 1000 w. Am Engr & R R Jour—April, 1901. No. 40144 C.

Siam.

The Railroads of Siam. An illustrated account of the roads, their construction and importance. 1200 w. Ry Age—April 12, 1901. No. 40313.

Single Rail.

The Lehmann Single-Rail Road (Die Einschienenbahn von A. Lehmann). Prof. A. Birk. A well-illustrated description of this single-rail system for industrial and field tramways, principally for freight. 1 plate. 1800 w. Oesterr Wochenschr f d Oeffent Baudienst—April 6, 1901. No. 40441 D.

Sleepers.

Cast Iron Sleepers on the Madras Ry. Extracts from the report of E. W. Stoney on the relative life and cost of timber and cast iron sleepers, with illustration of details of the design used. 1200 w. Ry & Engng Rev—April 6, 1901. No. 40234.

Snow.

Snow Upon Railways. From L'Illustration. Brief account of the methods employed for removing the accumulation of snow. Ill. 1700 w. Sci Am Sup—March 30, 1901. No. 40102.

Station Grounds.

Decoration of Station Grounds on the Philadelphia and Reading. Illustrates the grounds at several stations and gives details of the practice of this company. 600 w. Ry & Engng Rev—April 6, 1901. Serial. 1st part. No. 40233.

Switches.

Facing-Point Switch Protection, L. S. & M. S. Ry. Illustrated description of a signal lever attachment to the switch stand, arranged to be interlocked with the switch points, adopted as the standard device for the protection of facing-point switches on the road named. 900 w. Ry & Engng Rev—April 20, 1901. No. 40385.

Trestle Filling.

Relative Cost of Filling Trestles. I. O. Walker. Extracts from a paper in the Pro. of the Engng. Assn. of the south, describing and discussing work done on the N., C., and St. L. R. R. 2800 w. R R Gaz—April 19, 1901. No. 40382.

Trestle Filling on the N. C. & St. L. Ry. Extracts from a paper by I. O. Walker, presented before the Engng. Assn. of the South. Illustrated description of work on one of the divisions of this road. 2300 w. Ry & Engng Rev—April 13, 1901. No. 40280.

Trolley and Conduit.

Combined Trolley and Conduit Tramway Systems. A. N. Connett. Read before the Inst. of Mech. Engs., London, with discussion. Considers means of solving the problem when the current must in certain places be furnished otherwise than from the overhead wire; especially studying the open-slot conduit. Ill. 4300 w. Engng—March 22, 1901. Serial. 1st part. No. 40107 A.

Tunnels.

See Civil Engineering, Construction.

Wooden Railways.

Wooden Railways. W. B. Paley. Description, with illustrations, of some of the wooden railways built and their service. 1900 w. Sci Am Sup—April 6, 1901. No. 40219.

TRAFFIC.

Differentials.

Railroad Discrimination Against New York, and the Remedy. Abel E. Blackmar. Treats of discrimination against a locality in the interests of a carrier, and the rate problem. Discusses the differential agreement. 4800 w. Pro Am Soc of Civ Engs—April, 1901. No. 40522 E.

Long and Short Haul.

Long and Short Haul. Supreme Court decision in the East Tennessee, Virginia and Georgia case, involving rates to Nashville and Chattanooga. 6000 w. Ry Age—April 19, 1901. No. 40371.

MISCELLANY.

Canada.

The Railways of Canada. Interesting statistics showing great progress. 1400 w. U. S. Cons Repts, No. 1001—April 3, 1901. No. 40127 D.

European Railways.

European Railway Jottings. Charles Rous-Marten. Illustrates the engines that drew the funeral train of the Queen, also the latest Great Western engine. 2300 w. Loc Engng—April, 1901. No. 40129 C.

Great Britain.

The Railway Situation in Great Britain. J. W. Root. A discussion of railway conditions, and the problems to be solved, with suggestions for reforms. 6000 w. Ry Age—April 12, 1901. No. 40312.

Paris Exposition.

Railway Affairs at the Paris Exposition (Das Eisenbahnwesen auf der Letzten Pariser Weltausstellung). Hr. Kriesche. A paper and discussion before the Verein für Eisenbahnkunde on Paris terminal stations, American locomotives, weights of freight cars, turn-tables, etc. 4500 w. Glasers Ann—March 15, 1901. No. 40411 D.

Prussia.

The Development of the Prussian Railway System (Die Entwicklung des Preussischen Eisenbahnwesens). An abstract of an interesting debate in the Prussian House of Deputies on the management and equipment of the state railways; and also interviews with prominent technical men on the same subject. 9000 w. Zeitschr d Ver Deutscher Ing—April 13, 1901. No. 40409 D.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* JOHN R. DUNLAP, PUBLISHER.

Fuel Combustion.

A Catechism of the Combustion of Coal and the Prevention of Smoke. By William M. Barr, M. E. Price, $1.50; pp. 350. New York: Norman W. Henley & Co.

Applies the catechetical method to discussion of the generation of heat, in stationary and locomotive steam-boiler practice, from the fuels commonly found in the United States. Adapted to the use of engineers and firemen. With 85 engravings.

Iron.

Grundzüge der Siderolgie für Hüttenleute, Maschinenbauer, u. s. w.: Sowie zur Benutzung bein Unterrichte Bearbeitet. Erster Teil: Die Konstitution der Eisenlegierungen und Schlacken. By Hanns Freiherr v. Jüptner. Price (paper binding) 13 marks. Large 8°; pp. viii., 316; 11 tables and 10 text illustrations. Leipzig: Arthur Felix.

This first part of a complete work on the science of iron and steel, by the well-known Austrian authority, contains the preliminary part of the subject and treats of the microscopical and chemical constitution of iron and steel alloys and slags.

Sewage.

Report of the State Board of Health Upon the Discharge of Sewage into Boston Harbor. 1900. Transmitted by Sam'l W. Abbott, Secy. Size, 5½ by 9; pp. 87. State Printers.

A review of the subject in connection with the plans for the relief of the towns in the upper Charles and Neponset River Valleys. Concludes that it will generally be more economical to dispose of the sewage of these places by filtration upon land than by conveyance to Boston harbor.

Strength of Materials.

The Winslow Tables. Diagrams for Calculating the Strength of Wood, Steel, and Cast Iron Beams and Columns. By Benjamin E. Winslow. Price, $2.00; 11¾ by 9½; pp. 14, and plates xix. New York: The Engineering News Publishing Company.

A book for the practising structural engineer or architect, furnishing a rapid and easy means of computing sizes of beams and columns by the use of graphical tables. Its aim is to include all ordinary cases without loading the book with problems complicated or of unusual occurrence. The introductory pages are chiefly explanatory or supplemental to the diagrams, with notes on or demonstration of the formulæ on which the tables are based.

Tunneling.

Tunneling. A Practical Treatise. By Charles Prelini, C. E., with Additions by Charles S. Hill, C. E. Price, $3.00. Size, 6 by 9¼; pp. 311. New York: D. Van Nostrand Company

Enlarged from the authors' lecture notes, and explaining all the operations of tunneling with illustration from suitable examples. The book is descriptive, and avoids formulæ and difficult calculations. A very thorough treatise within the scope defined, with 150 diagrams and illustrations.

Water-Supply.

Public Water-Supplies. Requirements, Resources, and the Construction of Works. By F. E. Turneaure, C. E., and H. L. Russell, Ph.D. With a Chapter on Pumping Machinery by D. W. Mead, C. E. Price, $5.00, 21s. Size, 5¾ by 9¼; pp. 746. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

Prepared with reference to the needs of students and teachers rather than as an advanced work for specialists, and therefore concerned with fundamentals rather than details of practice. With this idea many problems, usually treated empirically, are subjected to analysis. Economy in design is emphasized and full treatment given to quality of supplies. Gathers together much heretofore scattered information. Illustrated and well indexed.

Water-Works.

Waterworks Distribution. A Practical Guide to the Laying Out of Systems of Distributing Mains for the Supply of Water to Cities. By J. A. McPherson, A. M. Inst. C. E. Price, 8s. 6d. $2.50. Size, 5½ by 7¾; pp. 154. London: B. T. Batsford. New York: D. Van Nostrand Company.

A somewhat elementary and didactic treatise, addressed particularly to those interested in laying out systems of distributing mains, as well as to students and candidates for examinations. The demonstration is made largely by a hypothetical "example district." Text illustrations and diagrams.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

VOL. XXI. JULY, 1901. No 4.

RUSSIA AS A MARKET FOR MACHINERY AND MACHINE TOOLS.

By A. H. Ford.

This fourth paper by Mr. Ford concludes the series of which the earlier numbers appeared in our issues for February, March, and April of this year. Its unavoidable postponement has been turned to an actual advantage, in that Mr. Ford is thereby enabled to analyze accurately the results of the Russo-American tariff conflict. He believes that the volume of American manufactures finding their way to Russia will not be greatly diminished. But even this comparatively favorable conclusion will be far from wholly gratifying to the United States exporter, when it is noted that the volume will be maintained only by adopting indirect and underground trade routes, playing largely in the ultimate into the hands of Britain and Germany. The logic of the situation can be met eventually only by such a revision of the outworn tariff system of the United States as Mr. Saunders ably argued in our April number.—THE EDITORS.

DIRECT effects of the recent fifty per cent. increase of duties on American machinery entering Russia have been actively debated. Therefore, it may be a source of consolation to the United States, if not to their European competitors, to learn that the largest shipment of machinery ever sent to any part of the world left New York city in March, after the DeWitte-Gage tiff—for Russia.

Russia is not given to cutting off her nose to spite her face. Machinery needed for state railways, or agricultural machinery, which the peasants must have, will not be subjected to the additional arbitrary tax; and as for machinery and tools for the ordinary Russian manufacturer, they will reach him as heretofore, indirectly, and escape the

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duty. Direct American export to Russia will probably show a shrinkage, Germany and England acting as clearing houses and being credited with Yankee ingenuity. In fact it is estimated that last year these countries sent over $20,000,000 worth of American products into Russia as their own, while the value of the direct export from the United States to Russia amounted to but $11,000,000. It is a common practice to remove the American name plate and substitute that of a German firm. Germany has a great advantage over almost every other manufacturing nation in that the Teutons have established branch banks in almost every large city of Russia, while their agents act as distributors, becoming in time the actual managers of newly established Russian works and naturally favoring home products and machinery. Moreover, Germany sells on long-time credit, while America, without banking facilities abroad, must demand cash payments; consequently the Germans find it profitable to purchase American machinery for cash, change the name plate so that they may secure any duplicate orders, and sell at an advance, on credit, the only terms on which the average business man in Russia can or will buy. The direct orders for American machinery, so far, come largely from the

9,000-TON CARGO OF AMERICAN AGRICULTURAL MACHINERY LEAVING THE DELAWARE FOR RUSSIA.

By courtesy of the McCormick Harvesting Machine Co., Chicago, Ill.

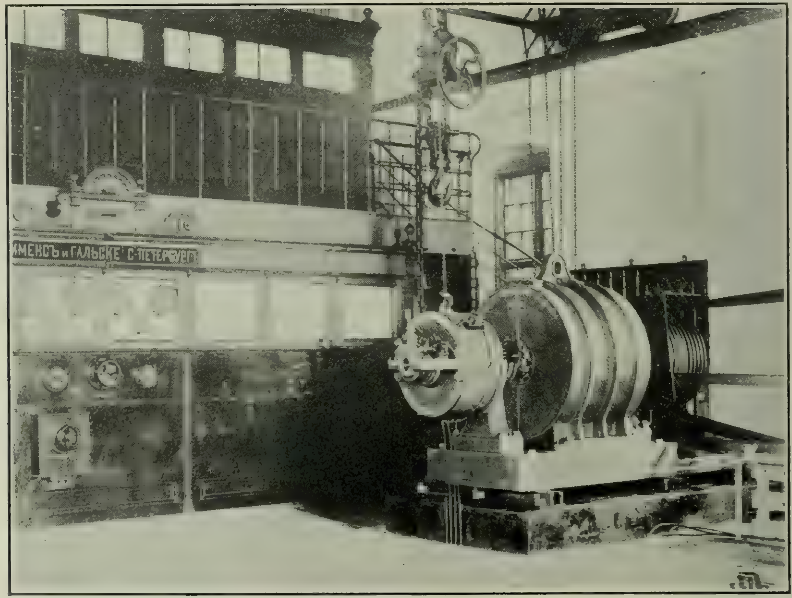
A MC CORMICK REAPER AND BINDER AT WORK ON THE RUSSIAN STEPPES.

Government itself. The manufacturers of reapers and harvesters built up their enormous business in Russia within a few years by sending out their own agents to establish offices and offer the machinery on long-time credit, final payment being often deferred for years until a good crop was harvested. The distributors act also as bankers.

A TRAIN-LOAD OF BOILERS FROM THE AMES IRON WORKS FOR EXPORT TO RUSSIA.

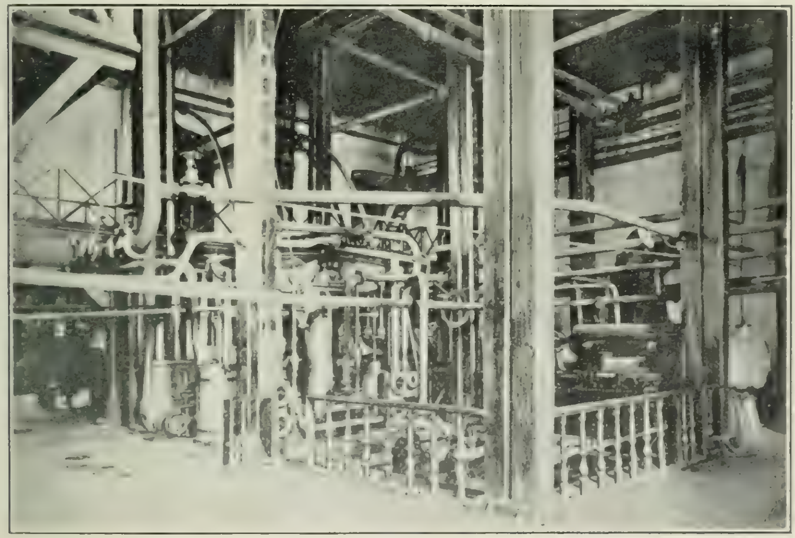
As an illustration of what even a little enterprise will do in the Russian Empire, it may be stated that the sending of a single agent (who spoke Russian) to Manchuria in behalf of the Ingersoll-Sergeant rock drill resulted not only in the introduction of the steam rock drill on the line of the Chinese Eastern railway, but necessitated the use of small boilers, which another American firm was called upon to supply.

It took five freight trains to carry the first order from the factory in America to the tramp steamer in New York on which they were loaded for Vladivostok. The agents for American agricultural machinery had also visited Siberia and Manchuria, so that with their shipments and that of the material needed for the building of the Chinese Eastern railway, enough freight was guaranteed to induce shipping men to put on a regular line between New York and Russian Far-Eastern ports, cutting down freight rates and opening the way for other manufacturers to enter the field.



FIRST INSTALLATION FOR TRANSMISSION OF ELECTRIC POWER, NOBEL FRÈRES WORKS.

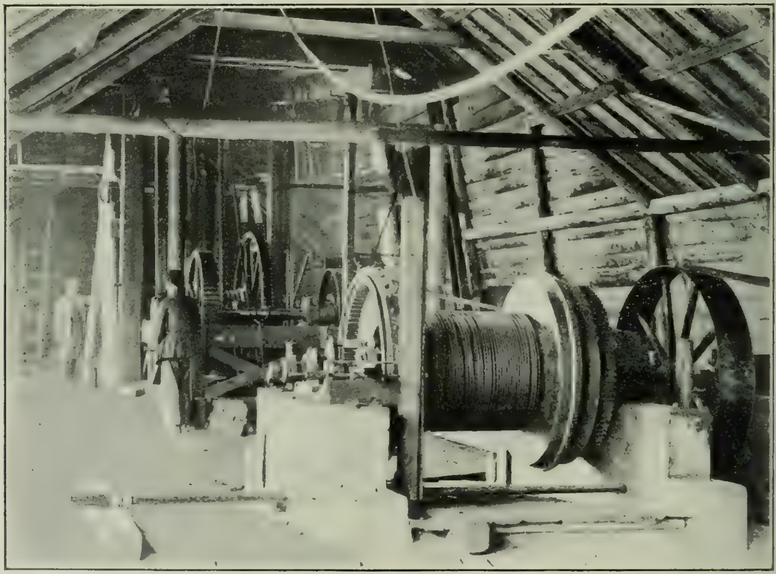
As the Far East is but 4,500 miles by water from the Pacific coast of North America and fully 12,000 from the manufacturing countries of Europe, it is but natural to expect that the greatest gains in the export of American heavy machinery, at least, will take place in this part of the Russian Empire. In fact, the building of the Chinese Eastern railway has done more to accelerate the introduction of American machinery into Russia than has any other one cause. It was for the steel bridges on this road that the first large American orders were placed. The Russian Government having ordered that no material manufactured outside of the Empire should be used, the practice of replacing American with Russian name plates became common; but when it was fully demonstrated that the American bridge work could be landed in Russia at half the cost of production at the Ural shops, the Government began to wink at the orders given by the engineers. As an indication of the progressive methods being introduced on the Chinese Eastern railway, it may be stated that quite recently an American firm was given the order for installing plants necessary for lighting the railway stations with electricity. The new tariff will doubtless induce several American firms to establish branch factories in Siberia. Only recently a large rice-mill plant arriving at Vladivostok was compelled to pay the full retaliatory tariff rate, which amounted to over $63,000. It is expected, however, that this will be remitted, as hitherto Russia has charged no tariff on machinery entering Siberian ports; if not, American-built dredges, when not ordered by the government, will be taxed $20,000 each before they are allowed to enter.



ELECTRIC DRIVEN AIR PUMPS IN A RUSSIAN REFINERY

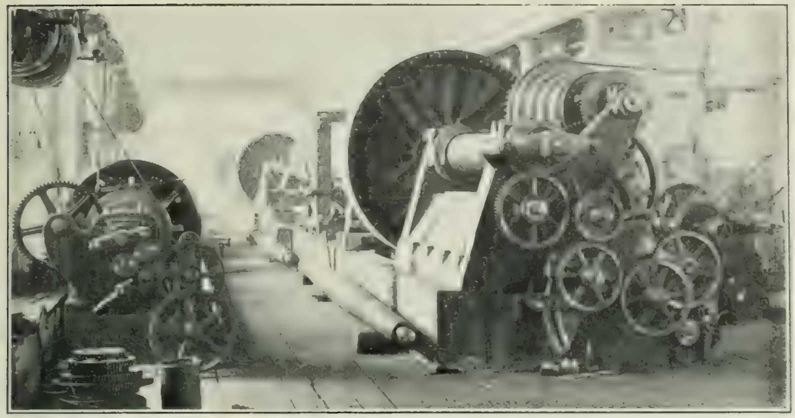
Accredited Russian officials have just made overtures to a Philadelphia firm to establish a plant on the line of the Trans-Siberian railway for the making of steel and the construction of cars and locomotives. A free site has been offered, lumber, coal, and iron privileges are to be granted, while the Government guarantees to purchase a certain number of cars and locomotives annually. The capital of $10,000,000 is to be raised in the United States and the original plant shipped duty-free from American ports. This is but one of the many indications that the Russian Government is willing to make any concession to those who can and will develop Siberian industries. Into Central Asia, cotton gins, cotton-seed-oil machinery, and American compressors, find their way in large quantities, while to the Caucasus region oil-well machinery is shipped, although an Anglo-American firm is now turning out tubing on Russian soil for the Batoum wells that produce more than half the world's supply of petroleum.

It is in northern and central Russia, however, that American plants and installations are most common. Many tons of machinery are sent every month for the factories going up about Moscow, but it is difficult to trace American machinery in Russia; the manufacturer delivers it f. o. b. New York, Philadelphia, or San Francisco, receives his money, and never gives the matter a second thought. One hundred pumps from one firm alone leave the United States every month for Russia; no one knows where they go in the vast Empire.



INTERIOR OF A DERRICK, SOUTH RUSSIA, SHOWING WINDING MACHINERY.

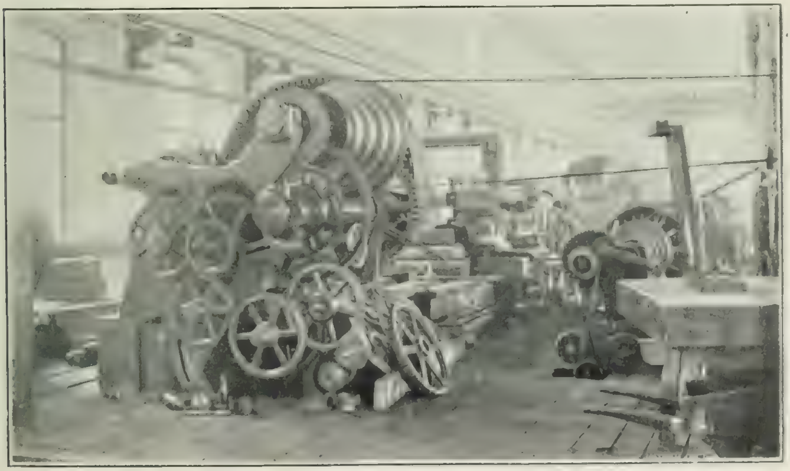
Agents of the Obouhoff Government works, St. Petersburg, visited America last year with a view to inducing manufacturers of air compressors, steam crushing machinery, and dredges, to establish plants for their manufacture in the Russian Government works; in this they have not been immediately successful, but it is interesting to note that in these, the largest works in Russia, employing as they do some 14,000 men, American tools and machinery seem to predominate. The Niles Company has installed at these works several of the largest



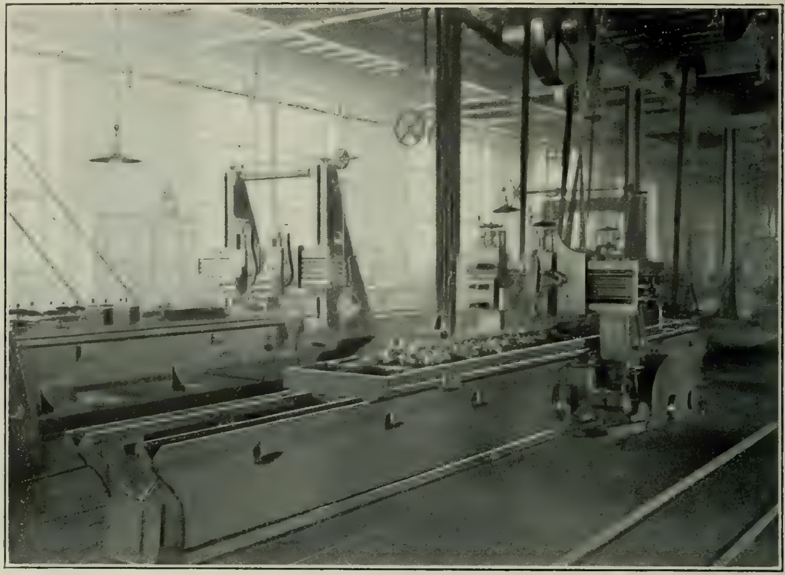
90-INCH GUN LATHES, AT WORK IN THE OBOUHOFF WORKS, ST. PETERSBURG.
Niles Tool Works Company.

gun lathes ever constructed anywhere, while at the Nevsky Mechanical works, also located at St. Petersburg, their American lathes turn out the crankshafts for the Russian navy. At Wiborg, Finland, much of the large plant is American; steel-tired car-wheel lathes and frog- and switch-planing machines turn out work for the State railways.

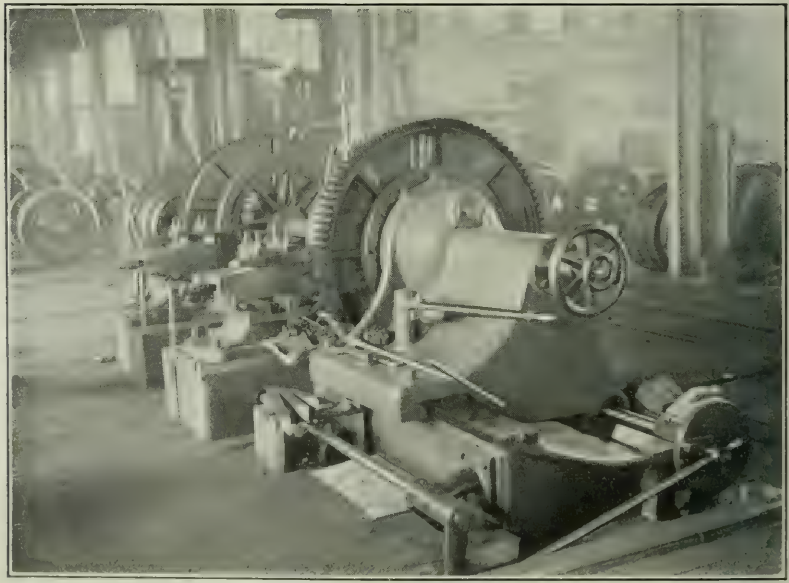
St. Petersburg offers, however, the best present opportunities for American enterprise in Russia. The Neva-St. Petersburg Ring Electric railway is to be constructed, bridges over the river and canals must be built, and of the 400,000 tons of iron to be used at least 60 per cent. will probably have to be imported. Then there is the new St.



ANOTHER VIEW OF THE 90-INCH GUN LATHES IN THE OBOUHOFF WORKS.

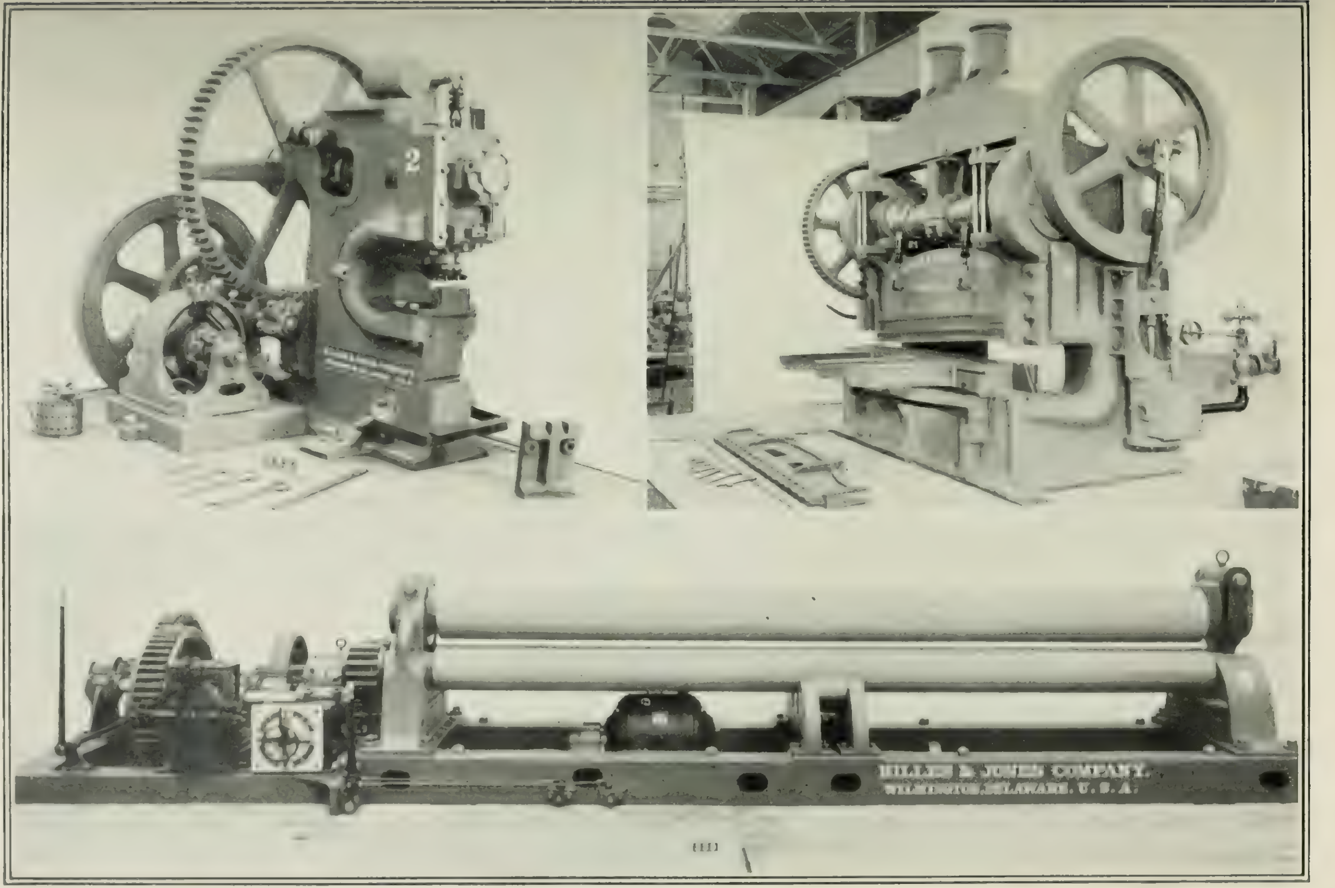


FROG AND SWITCH-PLANING MACHINE AT WIBORG, FINLAND, IN THE SHOPS OF THE FINLAND STATE RAILWAYS.



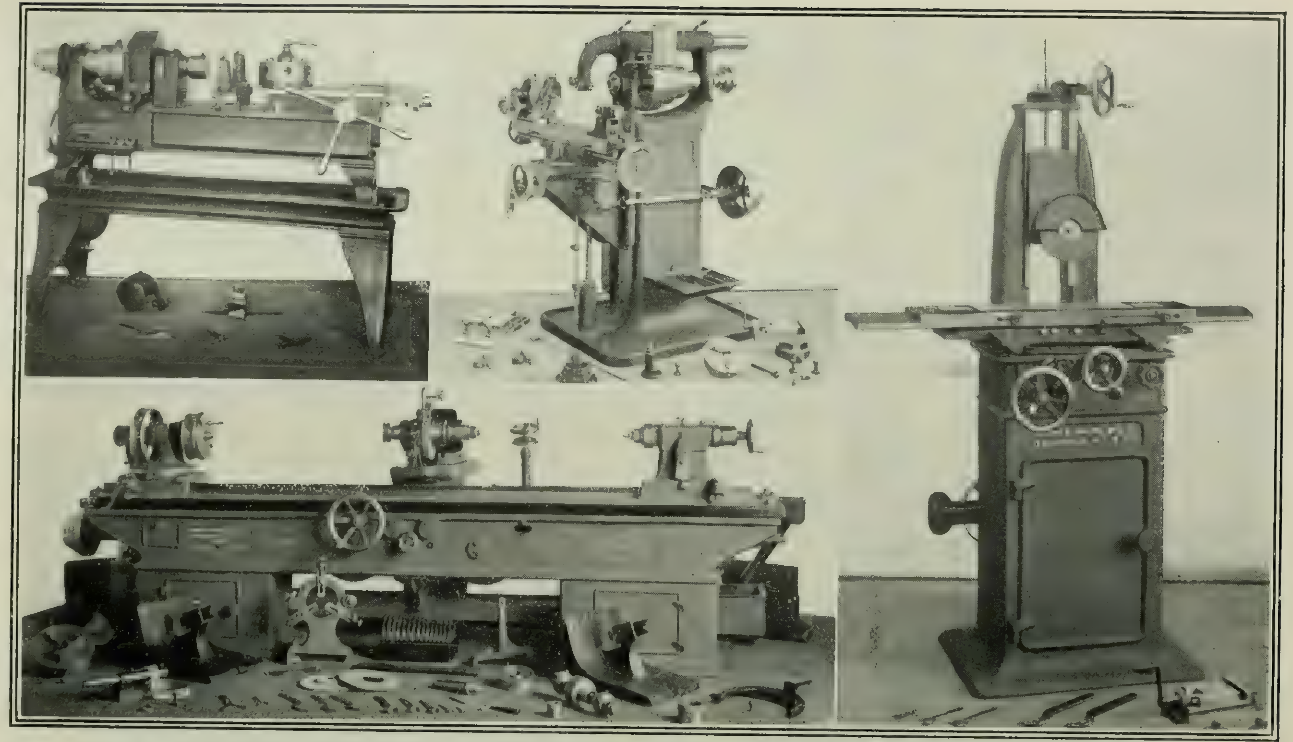
LATHE FOR STEEL-TIRED CAR WHEELS, SHOPS OF THE FINLAND STATE RAILWAYS, WIBORG, FINLAND.

Niles Tool Works Company.



SHIP BUILDING TOOLS EXPORTED TO RUSSIA FROM THE UNITED STATES.

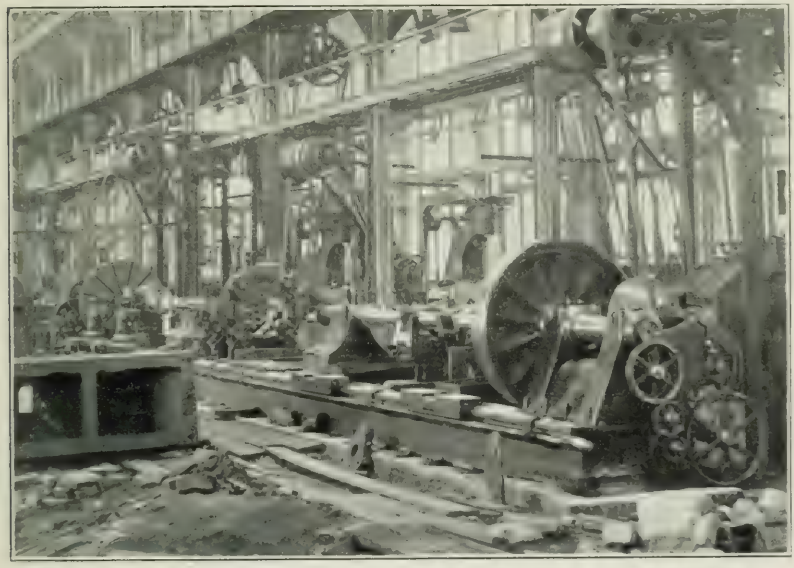
Punching and shearing machines and plate straightening or bending rolls. Hilles & Jones Company, Wilmington, Del., U. S. A.



GROUP CHARACTERISTIC OF THE KINDS OF TOOLS EXPORTED FROM THE UNITED STATES TO RUSSIA.

Screw machine, universal milling machine, surface grinding machine and universal grinding machine. Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

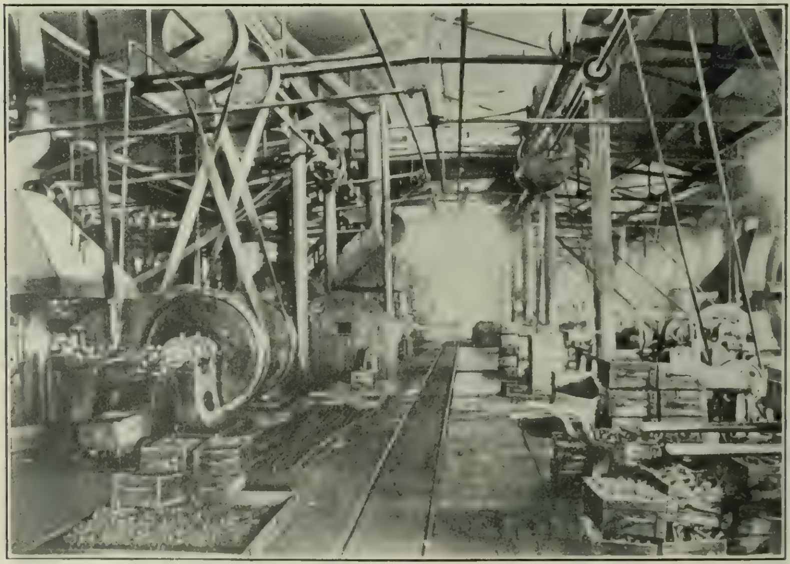
Petersburg-Moscow Railroad; much outside material will be needed in its construction, for Russia cannot yet manufacture enough rails and locomotives to supply the home demand. Quite recently the Tzar has authorized a railway connection with Viatka, which will make St. Petersburg, instead of Moscow, the Western terminus of the Trans-Siberian railway. The Westinghouse Company has been induced to erect an enormous plant at St. Petersburg for the manufacture of air brakes to equip every freight and passenger car in Russia, while at Saimova, near Nijni Novgorod, the locomotive works are equipped throughout with American machinery, 8,000 men are employed, and 300 locomotives are turned out annually, or 500 less than the actual demand. In spite of all her efforts to induce foreign capital to build new machine shops and make her independent of the outside world, Russia still looks abroad for certain kinds of tools and machinery foreigners have made her familiar with. Among the implements I have observed in use in the Russian Empire are: hoisting cranes, scales, planing machines, punches, shears, dies, milling machines, grinding machines, screw machines, compressors, boilers, all kinds of engines, steam rock drills, agricultural machinery, all kinds of railway machinery and equipment, ice-making machines, steam rollers, sanitary supplies, plate-straightening machines, crushing machinery, safes, steam-heating plants, tools of all kinds—so



60-INCH DOUBLE LATHE, INSTALLED IN NEVSKY WORKS, ST. PETERSBURG.
Niles Tool Works Company.

numerous to mention, in fact, that the list might be stretched out indefinitely.

The Germans are still the merchantmen of Russia, the Slav unfortunately not having successfully evolved from the farmer into the business man. Optimists and pessimists by turns, they organize companies capitalized at millions, merely to corner leather or coal, and are disappointed when the money is lost. A committee of representative Russians met a director of an American rock-drill company on his arrival at St. Petersburg with a request for the agency of the drill; they intended to issue stock to the extent of over a million rubles, the sole asset of the company being the permission of the American company to sell its drills in Russia. These are the incidents that discourage the average business man who visits Russia; but on the other hand there is much room for legitimate enterprise. An American who owns great mines in Siberia has within the past few years shipped millions of dollars worth of mining machinery into the center of Asia, that from the Pacific coast going overland through China on the backs of thousands of camels, while from Reval on the Baltic he has sent an entire trainload 4,000 miles across Europe and Asia, the Government clearing the track for the train and granting a freight rebate which made the expense merely nominal.



BOLT SHOPS OF THE SOCIÉTÉ D L'USINE MÉTALLURGIQUE, OF MOSCOW. OUTPUT 4,000 TONS A YEAR.

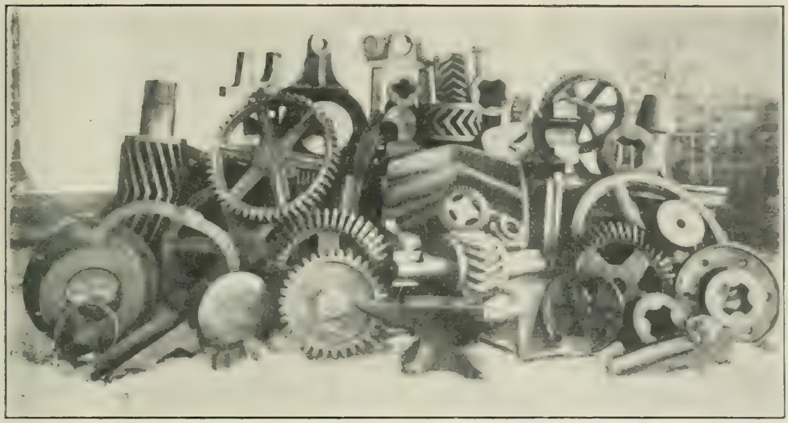
WIRE-NAIL MACHINES, SOCIÉTÉ D L'USINE MÉTALLURGIQUE, MOSCOW. OUTPUT ABOUT 12,500 TONS A YEAR.

Most American machinery destined for Russia finds its way first to Hull or Hamburg. From Hull the Wilson line sends direct boats to America, the Black Sea Ports, and the Baltic; the Russo-American exports are collected at Hull, and when forwarded, as often as not are credited as a British export to Russia. The exports of Great Britain to the Black Sea ports run up in value to tens of millions of dollars, and the Baltic trade is almost as valuable. For over fifty years the United States have been shipping to Russia via Hull; recently, however, Hamburg has become a rival, for the Germans make a specialty of packing machinery and forwarding it to Russia. They understand the intricacies of the tariff system and overcome all the petty annoyances that usually drive Americans frantic, without losing their tempers. After one experience with Russian obstructive methods, the average American shipper of small pieces of machinery is only too glad to deal through the German agent. It is only fair to state, however, that the Russians are remedying their antiquated methods.

While machinery from Germany seems to dominate the market, England also sends immense shipments. The great works of England and Scotland are called upon to equip the Tzar's model sugar refineries, and the immense ice breakers and great dredges are built by British workmen; but there is no denying the fact that in parts of the

Russian Empire, at least, the Englishman is intensely unpopular. For obvious reasons, Russia does not wish Englishmen admitted into her mechanical secrets in the Far East. It is but recently that an English firm, one of the largest doing business in the Far East, employed an American familiar with the price lists of his countrymen to travel over the Chinese Eastern railway to secure orders which were to be filled in America, yet this Yankee material must necessarily be carried inland on steel barges and river boats sent out from Great Britain.

It is not intimated that America is to have a "walk over" in capturing the markets of Russia for her machinery; there are many things militating against the continued use of American tools and machinery in Russia. First and foremost, German workmen are most excellent imitators. Next the loose ways of American exporters militate against them. Take, for instance, their method of packing. Delicate machinery is shipped in open crates; loose parts are wrapped in brown paper and tied with twine to a bar of the crate. Go down to any wharf in New York and watch the machinery for foreign export delivered there. It will be strange if you do not stumble over detached pieces that have become separated from the rest of the engine or lathe. The goods shipped to Russia are paid for before they leave the United States; therefore the purchaser has no redress. There is much in the Russian complaints of American methods. In St. Petersburg the Germans maintain a permanent mechanical exhibit. Russian engineers visit this, see what they want, and order c. i. f. An American agent may be in the city and offer the goods at a far lower price, f. o. b., but he can give no quotation c. i. f. and consequently loses the order. So prevalent is the shipment of American manufactures to foreign markets f. o. b. that recently the president of one of the largest locomotive works in America telephoned to a broker to ask what the initials c. i. f. meant; he stated he had telephoned several manufacturers but they could not enlighten him. He was informed by the ship broker that c. i. f. meant cost, insurance and freight; figured it out, bid for, and got the contract he was after. German and English merchants invariably ship c. i. f. They insist upon knowing just where the goods are going, as they may have an agent in that particular section upon whose territory they are encroaching. The purchaser is bound to sell at a fixed price, from which no deviation is permitted, the broker or middle man not being permitted to take advantage of the ignorance of the consumer. England has large sums invested in Russian industries and knows what implements and machinery are needed; moreover she has a standard, which the United States lack. In America a dealer



STEEL CASTINGS FROM THE SOCIÉTÉ D L'USINE MÉTALLURGIQUE, MOSCOW.

orders a pump, at such a price. In England he demands a Perm pump or a Jeffrey pump, knows the exact price at which he can buy and sell, and would take no other make. The Russians accustomed to this standard system cannot understand the American custom of substituting "something just as good." Other countries study the foreign markets and give their customers what they demand, manufacturing special machinery for each and every market, if necessary, while the American manufacturer too frequently insists on forcing his goods on the foreign purchaser for trial, whether they be suitable to the country or not; if not, a duplicate order is lost to America.

What is needed in Russia to advance American commercial export interests there is a corps of young business men who can speak the language, and thoroughly know the home market. Catalogues must be gotten out in Russian and given to the censor to be passed upon before they can be distributed. An American bank must also be established in St. Petersburg, with branches in several of the larger Russian cities; for the advantage lies with those countries that have banking facilities in Russia.

The manufacturers of other nations co-operate, working for their joint as well as individual interests. In America every firm carefully guards the secrets of its shipments abroad, sometimes going so far as purposely to make out incorrect manifests and to pay the penalty at the other end. When American business men learn to trust each other more at home they will be willing to take chances abroad. American banks will spring up in other countries, f. o. b. shipments will give way to c. i. f. consignments, and American export business will be placed on a solid basis which its rivals will not be able to shake.

THE PROPER DISTRIBUTION OF ESTABLISHMENT CHARGES.

By A. Hamilton Church.

I.—THE NEED FOR INTERLOCKING GENERAL CHARGES WITH PIECE COSTS.

It is self-evident that profitable manufacturing depends on selling the entire product at a sufficient advance over the entire cost. If the output could be dealt with as a whole, this would be an eminently simple proposition. In practice, however, the total sales are made up of a multitude of detail transactions, and each detail lot of product has a cost spread fractionally throughout a multitude of expenditures.

The problem of determining the true proportion of expense attaching to each piece, so that its price may be fixed to return its true proportion of profit, is the vitally important one treated by Mr. Church in the series of articles to which this paper is the introduction. The new light which he throws on the subject of cost keeping will be warmly welcomed by advanced managers everywhere. "Establishment charges" will perhaps be more quickly recognised by American managers under the practically equivalent term expense burden—the total difference between prime cost and inclusive cost of the product of the works.—THE EDITORS.

WRITING no less than sixty-eight years ago, Charles Babbage said:* "The great competition introduced by machinery, and the application of the principle of the sub-division of labour, render it continually necessary for each producer to be on the watch, to discover improved methods by which the cost of each article can be reduced, and with this view, it is of great importance to know the precise expense of every process, as well as of the wear and tear of machinery which is due to it." And in a subsequent chapter dealing with the "causes and consequences of large factories," he points out that in reference to any particular manufacture there will be a certain minimum proportion of indirect expenditure for supervision, lighting, clerical work, passage of materials from process to process, repairing, etc., which cannot be exceeded in any similar factory without a less efficient production resulting.

This is probably the earliest reference made by any public writer either to costs or establishment charges. Yet notwithstanding that the importance of such matters was realised by Babbage so early in the development of manufacturing industries, the lesson for various reasons fell upon deaf ears, and it is only today, when the principle of competition has attained its full growth and has become a matter of life and death, that the commercial organisation of manufactories is felt to have become a matter of prime urgency.

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* Economy of Manufacture, by C. Babbage, M. A., London, Knight, 1832.

In the present series of articles an attempt will be made to thresh out the question of establishment expenditure and its interconnection with costs, not merely of the output as a whole, but of the piece and process in detail. To many persons who have not given sufficient attention to the matter, such a problem will present itself, in the first place as hopeless, and in the second as superfluous. Show a person of this type how he can reduce his pay roll by £50 a year, and he will listen with respect. Hint to him that knowledge is power, and that absence of knowledge is weakness, and he will be alarmed, not at his own ignorance, but at the prospect of what he terms "unreproductive expenditure." A firm that will spend its money freely on plate glass and mahogany in its offices, often shrinks from the expense of getting to know what is going on in its shops.

Why is this? The true answer probably is that one is a familiar and conventional item of expenditure, and the other is "something new." One is an obvious and tangible asset, the other an easy subject of criticism for the irate shareholder who remarks "they have nothing of this kind of thing at so and so's." To spend money today for the sake of saving a much larger amount at some future period, even where the certainty is admitted, demands some moral courage; but to expend money for the purpose of raising efficiency, detecting waste, and preventing loss, demands strong judgment and confidence as well. Hence innovations in this department are made much more slowly than changes in the shops.

The difficulty of dealing adequately with establishment charges in their relation to piece and process is usually in proportion to the heterogeneity of the business carried on. In highly specialised businesses working on modern lines, it probably costs no more to maintain a close interconnection of charges and costs than to take out prime cost in any form. But in older places, where all sorts of things from steam engines to twist drills are included in one output, the difficulty is much greater, but on the other hand the need for and utility of such a connection is greater in equal degree.

At what stage in the growth of a business from very small beginnings a fully developed cost and expenditure system becomes a necessity is difficult to say. But that it should be introduced as early as possible is desirable for reasons unconnected with its immediate use. In a small works under the personal supervision of the proprietor, who is able to give so much of his time to the affairs of the shop that he is fully conversant with the progress of work through it day by day, a cost system of any kind has but little present value. But as it is in the nature of new businesses to expand into large ones, and that sometimes with considerable rapidity, with a consequent loss of grip of detail on the part of the proprietor, it becomes very important that records shall be available representing what was accomplished in the shop at the most vigorous period of its life, namely, when the need for expansion was becoming felt.

It is a not uncommon experience that expansions do not always produce the satisfactory effects anticipated. During changes of this kind something has evaporated, it is not known what, but the absence of which is recognised keenly enough in its practical effects. The real element varies, of course. It may be a less intense watch on the part of the proprietor, or it may be, with still greater probability, a dislocation of the previously existing relationship between work and the incidence of expenditure, which again may be due to a variety of causes that must needs be recognised before they are remedied.

We have not, however, to consider the case of the private proprietor alone. Probably today the larger number of new businesses are joint-stock concerns from the very commencement of their career. Innumerable companies are formed for the exploitation of some particular patent article, not infrequently under the supervision of the patentee, who presently demonstrates his unfitness for practical business management. How many vicissitudes do concerns of this type undergo, due to changes of management! Every capitalist with a taste for financing inventions can call to mind examples of this class. Every one can remember with what hopes and fears new blood has been introduced, and with what anxiety the next half-yearly or yearly balance was looked for, to lay bare the result of the change.

It is not yet recognised how immensely the task of a competent directorate, to say nothing of the advantages to a stranger coming fresh to a business to take over and re-organise its working, would be facilitated by the adoption, from the very first, of a thoroughly comprehensive method of recording shop work, including the connection of expenditure of all classes with the items of output on which they are incident. No board would think of carrying on operations without a set of commercial books arranged by an accountant in whom they had confidence, yet the equally important technical records are nearly always treated in an amateur spirit, with the result that no two undertakings collect this information on similar lines. It is commonly left to the taste and fancy of the manager to say what records, if any, shall be kept, and how far they shall represent anything real and useful. So far is this attitude carried that many otherwise experienced business men really and conscientiously do not believe that shop accounts are of any use at all.

Yet the same men would undoubtedly give short shrift to the cashier who shirked the detailing of his petty-cash account on the ground that to keep track of small detailed expenses was not possible, or at any rate not worth doing. Nevertheless, the possible waste represented by an undetailed cash account is as nothing to the possible waste represented by an undetailed wages roll. And still more important is it to remember that, just as the sum of cash expended is made up of hundreds of small items, which are and should be analysed and classified so as to give an intelligible idea of the wisdom of the expenditure, so the productive activities in the shops are made up of innumerable small jobs, which, if properly marshalled, will tell precisely the same tale as to the wisdom of the expenditure on them as the money payments in the cash analysis.

It is true that the broad results of a half-year's work can be read in unmistakable figures in the balance sheet. But the mischief is not only done by that time, but in the absence of proper shop accounts, it cannot be ascertained where is the element at fault. To introduce reform one must first know where reform is necessary. It is no answer to this to say that practical experience supplies the deficiency. A man with a file and a true plane surface can supply a duplicate of that plane surface if he has sufficient skill and works long enough, but he will produce the same result more quickly and surely if he has a machine tool of the highest class to aid him. And in proportion to the accuracy of the machine tool so will be the ease and speed of the performance. A modern system of organisation is a high-class machine tool. It can be done without, but not economically. That is all there is to it. The wise man will make his own choice.

Thus far the argument has been directed to the desirability of a modern method of shop accounting, even though only of the class which merely records, and does not work up the results into new forms. Attention will now be directed to the particular subject of these articles—the connection of work with the expenditure properly incident upon it. It will, of course, be readily understood that this further development implies the existence of a highly organised cost system. It cannot be worked at all in those cases where wages are merely analysed each week, usually by a more or less forced agreement, into the order numbers on which they have professedly been expended. Such arrangement, though admirable for the purposes of the commercial accountant, is useless for the technical accountant. And while the results required by the former are readily furnished by the operations of the latter, the converse of the proposition is a clear impossibility.

The clearest demarcation exists between direct (viz., allocable,) and indirect wages—between the wages of fitters and planers, and those of foremen, timekeepers, and messengers. But between direct and indirect *expense,* the distinction is not so obvious. Workmen's time is not without exception and at all times being employed on orders for customers or stock. Whilst it is evident that some wages never become direct expenditure on orders, all classes of wages are liable to become indirect expenditure. The same thing may be said of material. For this reason the unit selected from which all the subsequent erection is built up, is neither the wages as such nor the material as such, but the *job.*

A definition must be given of what will throughout these articles be meant by the term "job." In this respect the distinction drawn by Mr. Slater Lewis * between the job and the works order is adhered to. The works order may, and usually does, consist of a considerable number of distinct jobs. Practically the job may be defined as the amount of time spent by any particular workman on any particular piece or similar set of pieces. Thus, a works order for a lathe will include such jobs as: planing bed, cutting leading screw, milling slide rest, etc. If the works order were for six lathes of similar pattern, the jobs would be extended similarly—as, for instance: planing six beds, cutting six leading screws, etc. In the case of work done otherwise than on customers' or stock orders, the job would be for items such as: new screw for No. 45 lathe, altering position of band saw No. 67, etc. It will be evident that some jobs will be charged with material and some not. Mere process work is of the latter class. Generally speaking, while the works order sets in motion the activities of all classes of labour, the job is individual to each man, his day's work being made up, it may be of one job, or it may be of several jobs.

The whole output of a shop, for any given period, consists of a number of jobs, and of nothing else. When we know all there is to be known about these jobs, we can form a very shrewd idea of the way in which things are going in that shop.

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* "The Commercial Organisation of Factories."

Now the elements which enter into the cost of a job are many. To ascertain merely the actual wages and material spent upon it is undoubtedly something, but to consider these factors alone and unqualified as a basis for the comparison of the relative profitableness of work may easily lead to serious misapprehensions.

In many cases the desirability of introducing a third element into the costs becomes at an early stage obvious to the practical mind. The difference between a small cheap tool and some high-class expensive appliance seems to demand recognition in the costs of the work done on either. In seeking to remedy this, an attempt is frequently made to introduce what is termed a "machine rate" into the accounts—a charge per hour for each tool being made and debited to the job, in addition to wages and materials. This is not always an advance, however. While it is easy to see that a charge is desirable, it does not follow that the fixing of such charges is either simple or easy. Usually some arbitrary proportionate rate is made, supposed to represent the interest on capital sunk in the tool, and this reduced to a rate per hour is charged against the jobs done on that tool. The first objection to this plan is that tools are not in constant employment. But the interest, on the contrary, does not cease to run because the machine is idle. Hence this rough-and-ready settlement of the problem is deceptive and may even lead to false conclusions.

This illustration has been introduced here merely to show, by a simple and familiar case, the general tendency of all attempts to deal with shop establishment charges. It is true that by means of the machine rate no more is usually attempted than to burden particular jobs with some of the interest on the machines concerned. But this, though, as we have said, ineffectual even for the special purpose intended, gives a very definite and clear idea of the *principle* involved, viz., the spreading of shop expenses over jobs, job by job, upon some recognised basis closely connected with the time occupied and the way of doing the work.

Even on this rudimentary plan, it is easy to see that the prime cost and the shop cost have become different things. If two jobs take three hours each, the payment for labour being the same in each case, say 8d. per hour, we may have the respective costs of the process 3s. 6d. and 6s. 6d. respectively, if we assume machine rates of 6d. and 1s. 6d. in each case.

But interest is by no means the only item of indirect expense worthy of being identified with jobs. It is, in fact, one of the smaller of many items. Thus it is that prime cost is in extreme cases not even the larger half of shop cost, and in mass production may even cease to have any tangible value whatever.

Before going on to speak of shop expenses in detail and technically, something must be said of their relation to the administrative side of the business.

Shop establishment charges are, without doubt, in many cases the "lost factor," absence of which makes the difference between success and failure in a commercial sense. There is a wide difference between technical excellence and commercial efficiency. It is not making an article that is the object to be attained, but making it *at a price*. And where various classes of things are being simultaneously made, something more accurate than practical instinct is desirable as a guide when it is required to decide which line it will pay to exploit commercially to the greatest degree. In a very small undertaking this practical instinct may be sufficient, but we are not considering the case of very small undertakings. The moment the work gets too large in volume for all its minutest details to be carried in one head, the necessity for a close analysis and interlocking of expenses with jobs becomes marked.

Nor must it be supposed that the "departmentalisation" of undertakings is more than one step, though certainly a very necessary step, in the solution of this problem. To separate the expenses incurred in or in connection with the work or organisation of each shop does not usually help us to any knowledge of the interior economy of that shop, if more than one class of article are passing through it. In the rare case that a department contains machines of one size and pattern, performing exactly the same operations on a single variety of work, it is true that very little more would remain to be done, but this condition of affairs rarely obtains. Generally speaking, it remains true that departmentalisation is quite a separate transaction from the interlocking of charges with costs.

An important function discharged by shop cost as distinguished from prime cost is the information afforded to the draughtsman when considering the question of design. The designer has to arrange to give full play to the actual conditions of the shop, much as an architect has to consider the circumstances of the site, by which he is often fettered.

It is not a question of producing a purely theoretical plan free from all limitations of practice that he has to study, but how to arrange to make a given article with a given set of plant, and a given organisation, so that the capabilities of these fixed elements are utilised to the utmost.

It will be evident that the best chance of doing this exists where the actual shop conditions are fully known, and inter-related with the work already done. Great discrimination is of course necessary in considering these factors, but it is the natural course of things that as the industry increases in complexity, the intelligence required to conduct it successfully requires more and more careful training and selection. This is a tendency against which it is useless to protest.

A not unimportant matter on which the shop-charges question has a very definite bearing is that of valuation for stocktaking. When it is considered that the truth of a balance sheet must obtain all its vitality from the valuation of finished work and of work in progress through the shops, the immense importance of a correct basis for such valuation will appear. Unfortunately, there appears to be no sort of uniformity of practice with regard to this matter. In some cases prime cost is taken as the basis of reckoning, in other cases arbitrary percentages are added, and even in these latter there is a divergence of practice. Sometimes they are added to time only, sometimes on prime cost, but in no case, within my knowledge,* is any attempt made to discriminate between various classes of manufactures. Now, a moment's consideration will suffice to show that any system of general percentage must be most unfair. So must the method of basing valuation on simple prime cost. The reason is obvious. All valuation is an attempt to represent certain facts. The facts are indubitably these: the charges incident on a variety of articles as truly represent part of the cost of such articles as the actual direct wages paid on them. And these charges are rarely, it would be safe to say never, identical in their incidence on different classes of articles nor are they constant from period to period. Therefore an attempt to represent their value either by ignoring this factor of production or by applying an arbitrary increment or percentage equally on all, will produce not any approach to facts, but merely a fancy figure, which will be not even constant in its error. It is, in fact, a guess, and not the less so because based on figures. Arrangements of this kind probably originated the unkind saying that figures will prove anything, "except facts."

The cost of production, as dealt with in this series of articles will be considered uniformly as divided into three great divisions. First, the bare cost of wages and materials, which will be called Prime or

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* Exception must be made, of course, in the case of works organised on the writer's system.

No. 1 cost. Secondly, the prime cost plus the expense of production incurred in passing through the shops; this I shall refer to as Works or No. 2 cost. Thirdly, the works cost plus the expenses of the commercial management and selling organisation, which is termed Inclusive or No. 3 cost. This classification will be remembered better by examination of the diagram (Fig. 1) which represents the total sale price of an article dissected into its constituent factors.

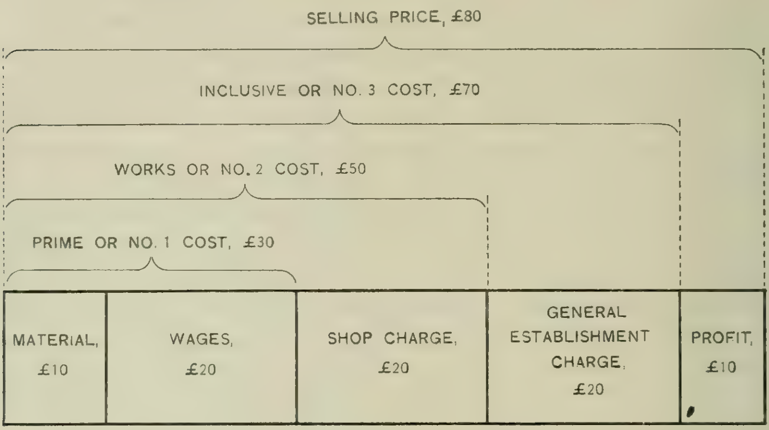


FIG. I. ANALYSIS OF THE SALE PRICE OF A MANUFACTURED ARTICLE.

In this diagram it will be seen that the cost of materials and of wages, taken together, make up Prime or No. 1 cost. Material, wages, and shop establishment charges make up No. 2 or Works cost. And material, wages, shop charges, and general establishment charges make up Inclusive or No. 3 cost. This last, subtracted from the sale price, gives the profit on that order.

The organisation of no works can be considered complete, until it is able to connect not merely its costs *of all classes* with its jobs, but also to check its financial position by aggregating its profits on sales item by item. Of course the latter process is merely a corollary or deduction from the cost factors. Having ascertained the latter in the form shown by the diagram, the net profit on any sale becomes a trifling matter of arithmetic.

Some attention should be given to a clear understanding at this stage of the very definite line drawn between works cost and inclusive cost. Works cost, as its name implies, represents the expenditure of all sorts upon the work, *up to its delivery* into warehouse. It is the cost of production, and of nothing but production. Inclusive cost is works cost plus what the commercial arm has spent on it to effect a sale. The distinction will become clearer if we suppose the case of a business having its works in the country, and its commercial office in the metropolis. The expenses of the former would fall into works cost, and the expenditure of the latter would be classed as general establishment charges. It is, of course, understood that all the correspondence, packing, etc., was performed by the metropolitan office, and that the works has nothing to do but to manufacture.

There are, of course, certain expenses which may be doubtful and their inclusion in one division or another is subject to the actual circumstances. Of this kind are draughtsmen. In some cases, the cost of drawings is certainly a works expenditure and chargeable to the job. The same applies to patterns. But, generally speaking, the basis of division is this: If a drawing or pattern is chargeable against a given order, it should be treated as part of prime cost, but in all other cases as a general establishment charge—never in any case as a shop establishment charge.

The necessity for and the justice of this distinction between shop charges and general charges (works cost and inclusive cost) hardly needs insistence. It has been ably and exhaustively argued in the work of Mr. Slater Lewis, already referred to, but the argument may be briefly recapitulated here.

Nothing is naturally more distinct than the operations of making and selling. They require different instincts and widely separate talents. An undertaking may be most efficiently organised and managed on one of these sides, and yet be unsuccessful, because what is gained in one set of efforts is lost in another. What is more useful, therefore, than to make this natural division of work to be reflected by a similar division in the system of accounting? It is the easiest and simplest of all the modifications with which we shall meet, because it is the most obvious and fundamental.

In the articles which follow, works cost will occupy nearly the whole of the field. This is because as yet general establishment charges are not capable of any great amount of detailed analysis. But by keeping them separate and distinct, and thus excluding them from affecting the operations of the works, we are enabled to follow the latter in very great detail, and to feel sure of our result.

Mr. Church's next paper discusses the different methods of apportioning indirect expense to separate items of work.

STEAM ENGINEERING IN PAPER AND PULP MILLS.

By William D. Ennis.

The paper-making industry, while itself specialized, is typical of many lines of manufacture in which steam is used largely for purposes of heating rather than of power. Mr. Ennis paper therefore has a wide scope in possible suggestiveness outside of its immediate topic.—The Editors.

FOR the greater part, the development of the paper and pulp industry in the United States has been unaccompanied by the efforts of professional engineers. The pioneers of paper manufacturing belong to that hard-headed and eminently successful type which inherits or assimilates, almost without effort, a species of engineering commonsense that is apt to be amply self-satisfying and usually works out in an incomprehensible way without doing any particular damage to person, property, or pocket. The man in the paper business has had his water power for all of his principal departments of manufacturing, and has seldom been troubled over nice questions of economy in the motive force of his plant.

At the present time, the old and the new stand in juxtaposition. Mills can be found which are operated entirely by steam power, and so economically as to give many a bad quarter-of-an-hour to the old water-power mill man who is "muddling along," gratified at least to know that steam, excepting for the dryers and stock boilers, need not worry him. The growth of the wood-pulp industry, especially in connection with the chemical methods of treating wood fibre to secure stock for the finer grades of paper, has led to the point where, water power or no water power, the steam plant must be one of the first considerations.

Probably in no line of manufacturing industry, excepting in sugar refining, is there so great a range and complexity of operations involving the use of steam as in pulp and paper making. The intricate and varied system of pressures and temperatures necessary, and the extensive use of hot water in processes, give openings for enormous wastes and opportunities for fine economies. Where all low-pressure supplies of steam are taken direct from the boilers, and water for manufacturing is heated by live steam, a mill cannot compete with one driven hydraulically; but when all such services are performed by exhaust steam from the engines, the only difficulty in eliminating the cost of fuel for power is the utilizing of the entire product of exhaust.

In the paper mill proper, the extended use of steam has grown to be essential to large production. Washing and beating are greatly facilitated by the use of boiling water in diluting the stock; and when the equipment is crowded beyond its normal capacity, only live steam will keep the machines supplied. The operations of bleaching are most economically performed when cold water is used; but again, in order to increase production, direct steam must be employed, economy being sacrificed in behalf of capacity.

The Fourdriniers need, in some cases, as much steam as would be required by the engines to drive them. The machine room, which contains the former, requires special methods of heating and artificial ventilation, involving large steam consumption, in order to prevent the vapor, rising from the moist sheet traveling over the dryers, from condensing on the under side of a cold roof and falling on the paper below. The supercalendars require steam to moisten the sheets before they strike the rolls.

In the bleach and rag boilers and in making hot size, direct steam plays an important part. Most of the large mills of America are located where most of the occupied rooms must be artificially warmed during the greater part of the year. All of these conditions result in constantly increasing demands upon the boilers. If the power of the mill is obtained from water, there must still be a system of steam generation and distribution at high and low pressure. The mill owner finds it difficult to regulate or anticipate the demand. His fuel bill is high. He notes that his competitor gets all of this process supply of steam by way of his engines, incidentally letting it expand and do some work. He does not know the amount of his competitor's fuel bill, but wonders, perhaps, if it is any higher than his own. He compares the slipshod, luckless way in which his little steam department is handled, with the business-like system of the other man, and wonders if, after all, his water power is one of Nature's blessings for which he makes no compensation and to which he need give only the scant recognition of a place among the assets of his annual balance sheet.

The dilemma is even more puzzling in a pulp mill, making stock by cooking spruce or poplar chips with steam, in contact with caustic soda, sulphurous acid, or any other substance that will extract the pitch from the fibre. In the sulphite process, the acid is vented as a gas after having performed its functions, and passes off from the top of the digester, leaving most of the separated pitch in contact with the pulp. The subsequent operations, on which the economy of the process depends, are accomplished without the use of steam or hot water; but the further treatment of the pulp, before it is in condition to be rolled into a sheet of paper, involves a multitude of uses of both.

In the soda process, one of the nicest economies known to manufacturing industry has been developed far toward perfection. Caustic-soda solution remains in liquid form at the temperature at which the fibre is cooked in the digesters. When the blow is made, the fibre, caustic, and resinous extractions pass together into the blow tank, accompanied by a large amount of steam that it seems impossible to save. From here, the mixture is discharged and washed down into the washing pans, where hot water and steam are blown into it until the soda solution, now black and thick from its contents of pitch, passes through the perforated false bottom and leaves behind a comparatively clean fibre. At this point the economizing system enters. The "black liquor" flowing out of the bottom of the washing pans contains two substances—caustic soda and pitch. The former constitutes one of the serious items of expense in the plant. The latter is good fuel.

In order to utilize both of these substances, it is only necessary to burn the liquor. As it returns from the washing pans, however, it is in too dilute a state to ignite. It is therefore evaporated down until it is at a density of 32° Beaumé. This evaporation is conducted in closed cylinders under a sequence of combined steam pressures and vacuums. The thick liquor is then fed into a rotating conical furnace, having its smaller end abutting against an ordinary steam boiler. It ignites at a high heat and forms a very hot, strong flame, the pitch being completely burned, leaving a residue of sodium carbonate, or black ash, which rolls out of the large end of the furnace and falls to conveyors which take it back to the mixing tanks.

The efficiency of the operation, as far as the recovery of caustic soda is concerned, is very high. In some plants, 85 per cent. is attained as the "recovery"—that is, 85 per cent. of the original strength of the soda solution is returned to be used over again. From a steam standpoint, the process is even more interesting. In the process of concentrating the black liquor, low-pressure steam (from 5 to 40 pounds) is used. This is supplied primarily through a reducing-pressure valve or "pressure regulator" of the lever form, which can be adjusted by a sliding weight on the lever. A pump is supplied to feed the evaporating chambers with black liquor, and another to draw out the concentrated liquor and deliver it to the rotary furnaces. There must be a vacuum pump and condenser to facilitate the boiling of the solution. The hot drip water from the shells is usually employed in manufacturing processes, and a pump of some kind must be provided to handle it. These four pumps are in most cases direct-acting steam-driven, the exhaust being carried to one of the shells of the evaporator.

If the rotary furnaces could develop a sufficient amount of heat to enable the boilers attached to supply all the steam required by the evaporator and its auxiliary pumping equipment, the process would be ideal, and the cost of operation practically *nil*. This is not ordinarily the case. It is usual practice to take live steam for this purpose direct from the power boilers, and this demand for steam forms a heavy and inconstant load that does not make for great economy as far as the steam plant is concerned. The waste is at a minimum when the pumps are power-driven, the hot drip water properly tempered and wholly utilized; and reserve tank capacity sufficient in amount is provided on both sides of the evaporator so that the demand for steam may be as steady as is practicable.

The hot drip water is not usually employed for boiler feeding. A slight excess over the proper level of the liquor in the tubes results in the passing over of a considerable percentage of caustic soda in solution. In traces, this would be a benefit rather than an injury to the boilers, as it is cleansing in its action and softens the hard scales formed by lime sulphate. An excess, however, causes the boilers to foam violently, and it is the possibility of such an excess that stamps the returning of the evaporator drip as dangerous practice. In washing operations, however, where hot water is necessary, the evaporator drips can be safely and economically employed; but again the process has a flaw, in that the amount of water furnished, while at a suitable temperature, is not ordinarily in sufficient quantity for the work. An auxiliary and supplementary source of supply is necessary, and in producing this another call is made upon the equipment of the steam plant.

Turning again to the recovery department of the process, there is the steam generated by the rotaries to be utilized. If this could be thrown in with the main steam system of the plant, all would be well; but the combustion of black liquor, while violent, does not compare in calorific effect with that of coal. The maximum steam pressure that can be maintained in the former case is about 100 pounds. It is rarely safe to connect rotaries and power boilers into a common system when the pressure is in excess of this. A more efficient proportioning and arrangement of the furnaces and heating surfaces may in the future facilitate the removal of this difficulty, but at present, in high-pressure plants, a separate disposition must be made of the steam generated in the recovery process. The most efficient and satisfactory scheme of operation, under present conditions, is to pipe the rotaries to a separate steam main. This leads through a pressure-reducing valve to the evaporators. An auxiliary supply to the latter is formed by connecting the main steam system of the plant, through a pressure regulator, with the steam main over the rotaries. The first regulator would be adjustable; the second would be set to reduce from the main-line pressure to that which can be maintained by the rotaries. To provide a disposition for the recovery steam supply when the evaporators are not running, as might be necessary in case of excess reserve liquor between the evaporators and the rotaries, the steam line of the first-named should be connected through a third regulator with the low-pressure heating and process supply system of the mill.

To develop maximum efficiency, the rotaries must be kept clean. The black ash is very light, and rapidly fouls the boiler tubes, smoke breeching, and stack. Where any form of artificial draught is used for the main boiler plant, it is necessary to have a separate stack for the rotaries. It adds greatly to the appearance and performance of a plant to use separate stacks in any case. The boiler tubes should be blown out at least every twelve hours during operation, and should be scraped weekly. When blowing out, unless special precautions are taken, the tubes will not be cleaned. The black ash will return and settle through the tubes round the one being cleaned, and a vent pipe, preferably with a small disk fan inside, should be carried off from the forward end of the boiler setting, to convey away the ash as it is blown through from the back. The smoke breeching should be made of heavy iron, thoroughly braced and guyed. It will not retain its shape if simply hung from straps.

The rotary furnaces, boilers, and black-ash storage departments should be kept in a separate building if possible, or at least walled off from the evaporating apparatus and main boiler plant. It is best to confine the black-ash nuisance within the narrowest limits possible.

The supply of steam required in the processes of manufacturing pulp and paper forms one of the largest burdens on the power plant. Mention has been made of most of the high-pressure work. Many of these requirements could be as well supplied by dripped coils receiving low-pressure steam, of which there is likely to be an ample supply, the condensation being further utilized. In some cases, hot water would fill the purpose usually served by live steam, at least to a large extent.

The obvious method of supplying the Fourdrinier dryers is from the paper-machine engines. These will ordinarily supply an excess, which can be used in the method above indicated, or for warming rooms which require heating, or for heating water. If more low-pressure steam is needed than the machine engines and the rotaries can furnish, one or more of the small engines of the plant could be run on back pressure sufficient to supply it.

The pressure on the dryers must be regulated in accordance with the speed, weight, and dampness of the paper passing over them. This regulation is usually accomplished by means of a pressure-regulating valve of the spring type. The tail rod projecting from the spring terminates in a cross head moving between a pair of guides. The paper passes over a roll which is connected to a cross head. If the paper is not sufficiently dry, the roll will stretch it out, opening the spring and the valve and admitting more steam to the dryers. The supply to the regulating valve is, of course, from the engine exhaust, but live steam, at a pressure reduced to the back pressure carried on the engines, must be provided for as auxiliary. In addition to this, it is frequently desirable to run a higher pressure on the last few banks of dryers than the rest of the machine requires or the engines can furnish. This is produced by live steam, reduced to, say, 25 to 35 pounds. Where the evaporators are not too far from the paper-making department, these two demands might at times be supplied advantageously from a single main line. The drip water from the Fourdrinier dryers should not be wasted. Other sources with which it could conveniently be combined should furnish the initial hot-water supply for the entire plant.

The paper-machine engines, and any other engines that are distant from the power-plant center, need not be highly economical. What is needed of them is a minimum requirement of care and attention with maximum security against breakdown or racing. The exhaust from these engines should all be utilized, in the methods indicated above, for the supply of low-pressure steam for heating and processes. A back-pressure valve on a branch from the main exhaust forms a safety valve to the entire system.

The main engines of the mill, which should be concentrated in a single room, even at a considerable additional expense in driving, should be grouped into two sets. One set should furnish the exhaust steam required for heating water for feed and manufacturing. This will require an engine or engines of indicated horse power of from ¼ to ⅓ the total boiler horse power of the plant. It will run at a slight back pressure, as the heating that could be done in a primary heater placed between the cylinder and a condenser would not be sufficient. If the demand for hot water can be regulated so as to be fairly constant, and the engine is of suitable size and is suitably loaded, an open feed-water heater will most effiectively utilize the heat of the exhaust steam, raising the water temperature above 200 degrees. The remaining engines should be designed and operated in the direction of high cylinder economy. They should be compounds, supplied with steam at not less than 150-pounds pressure, and should be run condensing. A primary heater can be placed on the main exhaust line, but it should be made large so as not to decrease the vacuum in the low-pressure cylinders of the engines, and at times its use will not be required. The small pumps, condensers, and auxiliary machinery in the boiler house and main engine room should be exhausted into a supplementary heater at a back pressure of 5 to 10 pounds.

Hot water for the various scattered manufacturing processes must, in many cases, be supplied nearest the process served. This may require exhaust or live-steam heaters at various points. The main supply of hot water, for both boiler feed and manufacturing, should be furnished primarily by the drips from the dryers, evaporators, steam lines, engine separators, etc., and the hot discharge water and condensation from the engine and evaporator condensers. These should all be led to a common point, forming the hot well of the plant. The level in this should be maintained at a fixed point by an automatically controlled supply of cold water. A pump, preferably power-driven, placed at such an elevation that the hot water will flow by gravity into it from the hot well, should discharge this water, say at 110 degrees to 130 degrees, to the primary heater or around the primary heater to the open heater above mentioned. From the open heater, the supplies for boiler feed and manufacturing should be kept separate, and if possible, measured. Any further heating on either line can be done in the supplementary heater. The temperature attained by the boiler-feed water at this point will determine whether it is advisable to install an economizer. A net gain of one per cent. for about 12½ degrees of heating above the supplementary-heater temperature could be thus realized.

With such an arrangement of engines and water-heating apparatus, with the main power units thoroughly concentrated, and the piping system designed for high efficiency and small loss, with auxiliary pumps power-driven, and with equipment so arranged as to be adjustable for all reasonable conditions of loading, the direct demand for steam in manufacturing is at a minimum, and the steam-driven paper mill may approach closely in economy the modern power plant.

THE MECHANICAL EQUIPMENT OF THE SHIP-YARD.

By Prof. J. H. Biles.

Professor Biles' preceding papers appeared in THE ENGINEERING MAGAZINE for May and June. In them he dealt with the influence of equipment on the cost of production, the essential operations of ship-building, the principal classes of machines required, and the tools for working the frames and the plating.

Electric and pneumatic appliances were necessarily carried over to this concluding article, which otherwise deals generally with general arrangement and transport facilities, and is especially interesting in its comment upon the bearings of the revived activity in ship-building in the United States. THE EDITORS.

PNEUMATIC tools have not been used to any great extent in British ship-yards up to the present time. In America, especially on the Great Lakes, hand rivetting and caulking have been in a number of cases entirely superseded by pneumatic rivetting and caulking machines. These tools usually consist of a cylinder in which a piston reciprocates, and thus a series of blows is delivered against the end of the rivet die, caulking tool, or chisel, as the case may be.

Figure 57 is a sectional view of the Cleveland pneumatic hammer. Figure 58 shows a section through the Boyer pneumatic hammer for chipping and caulking. The tool is fixed in a bush at one end and the head of this tool is struck by the piston, which is shewn in its furthest back position in the lower figure and in its striking position in the upper figure. The Boyer pneumatic long-stroke rivetting hammer, Figure 59, is a development of the principle embodied in the caulking and chipping hammer. The weight of this hammer, said to be suitable for 1-inch rivets, is only 18 pounds. Perhaps experience in shell work of ships will shew that a heavier hammer will make better work. In conjunction with this rivetting hammer a corresponding pneumatic holder-on must be used, as owing to the rapidity of the blows the ordinary holding-on hammer cannot be brought back into position between the blows. The pneumatic holder-on is shewn in Figure 73. In cases where the two ends of the rivet are accessible, the rivetter and holder-on are combined in one tool by means of a yoke, but in all other cases, such as for deck, shell, and bulkhead rivetting, the two tools are separate.

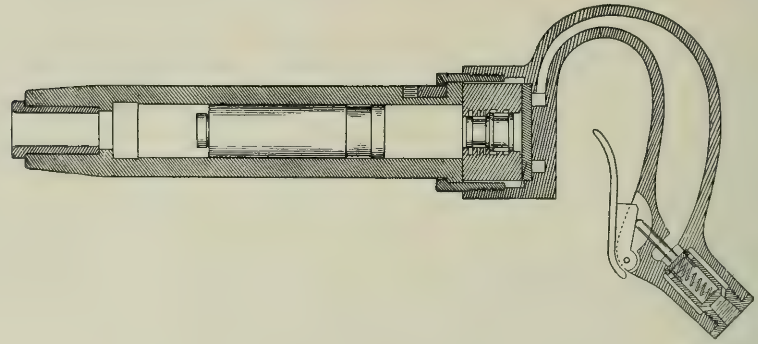


FIG. 57. SECTIONAL VIEW OF PNEUMATIC HAMMER.
Cleveland Pneumatic Tool Co., Cleveland, O., U. S. A.

Yoke pneumatic rivetters are shewn in Figures 60, 61 and 62. For deck work a rivetter of larger type not shewn in the figures is employed. A pneumatic holder-on has to be employed with the latter type, but not with the former. Figures 60 and 61 are photographs shewing the method of working the yoke pneumatic rivetter on a beam and a stringer, respectively, of a ship. Figure 62 shews the small yoke

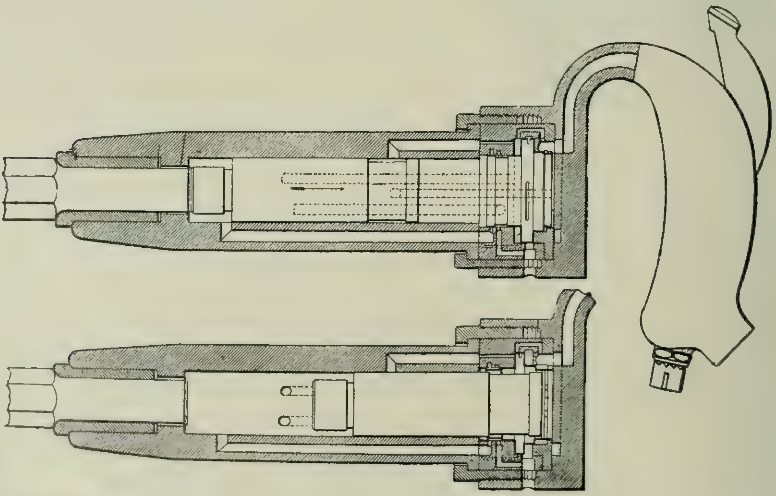


FIG. 58. SECTIONAL VIEW OF BOYER HAMMER FOR CHIPPING AND CAULKING.
New Taite Howard Co.

rivetter at work on ¾-inch rivets in the lower-stanchion connection of a vessel under construction.

Figures 63, 64, and 66 illustrate the methods in which the shell rivetter is employed. In Figure 64 the rivetter is at work driving in countersunk rivets in the lower bilge strake. In Figure 63 it is at work on heavy rivets in flat plate keel, and in Figure 66 on ⅞-inch countersunk rivets in the side of ship.

The present type of tool seems to work well in the smaller sizes of rivets and where there is only double rivetting, but with three or four-ply rivetting, especially with heavy plates, there seems to be a difficulty in properly closing up the work. No doubt with a suitable design of rivetter and holder, and with more experience, this difficulty will be eventually overcome. The advantages of these tools are many, amongst which may be mentioned: The rivets are closed more rapidly and at a higher temperature, the axis of the rivet and tool may be always kept in line, and the holes are well plugged. There is always this great advantage—that the tools, even when the rivetter and holder-on are combined, are of comparatively light weight, the largest size, with about a 70-inch gap, weighing about 220 pounds, while the smaller sizes run as low as 83 pounds. Mr. Babcock, in a paper read before the Institution of Naval Architects in 1899, gave the following figures as shewing the relative cost of the different styles of rivetting for shell work on one of the lake steamers:

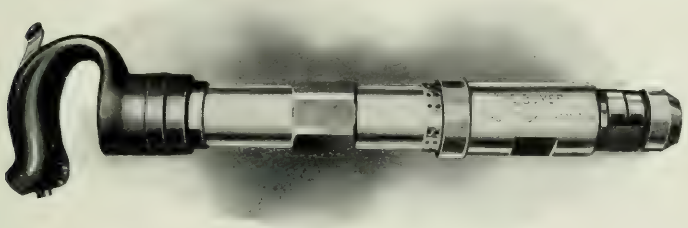


FIG. 59. NEW BOYER LONG-STROKE RIVETTING HAMMER.

Drives rivets up to 1-inch by hand, 1¼-inch in frame; adapted to all kinds of rivetting, including steam-tight boiler work; 9-inch stroke; estimated speed 800 per minute; weight 18 pounds. Chicago Pneumatic Tool Co

Hand (piece work)	3.99 cents
Hand (day work)	7.69 cents
Air	2.96 cents

The amount that should be added to the machine cost to cover in-

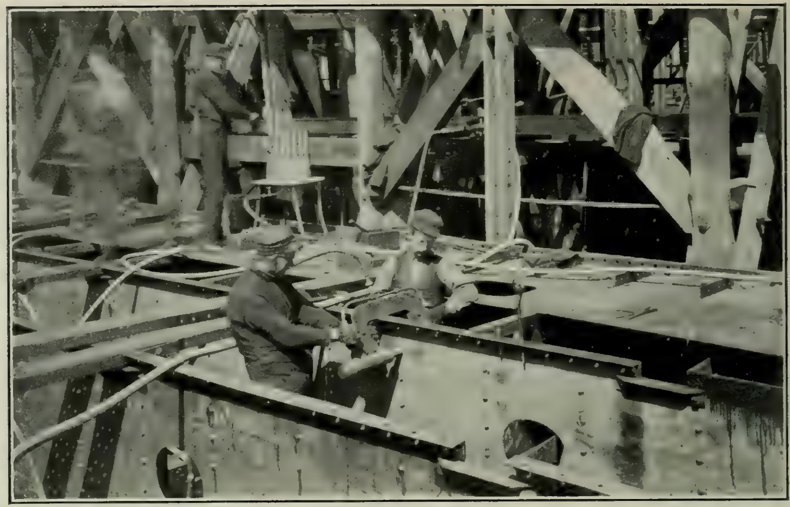


FIG. 60. PNEUMATIC RIVETTER AT WORK ON THE FRAMING OF A SHIP.

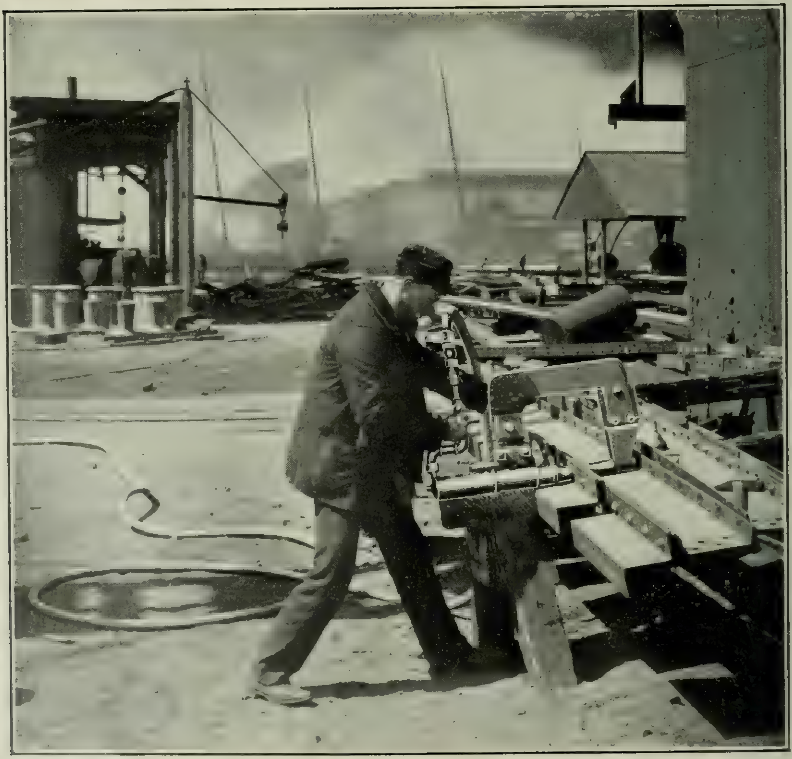


FIG. 61. DRIVING $\frac{3}{4}$-INCH RIVETS IN SIDE STRINGERS WITH SMALL YOKE RIVETTER.

Courtesy of the New Taite Howard Company.

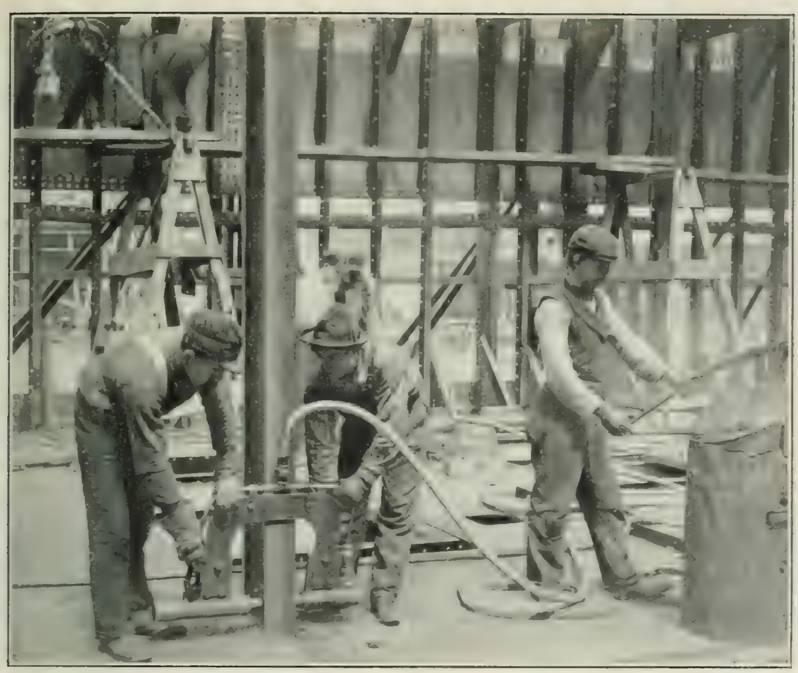


FIG. 62. DRIVING $\frac{3}{4}$-INCH RIVETS IN LOWER STANCHION CONNECTION WITH SMALL YOKE RIVETTER.

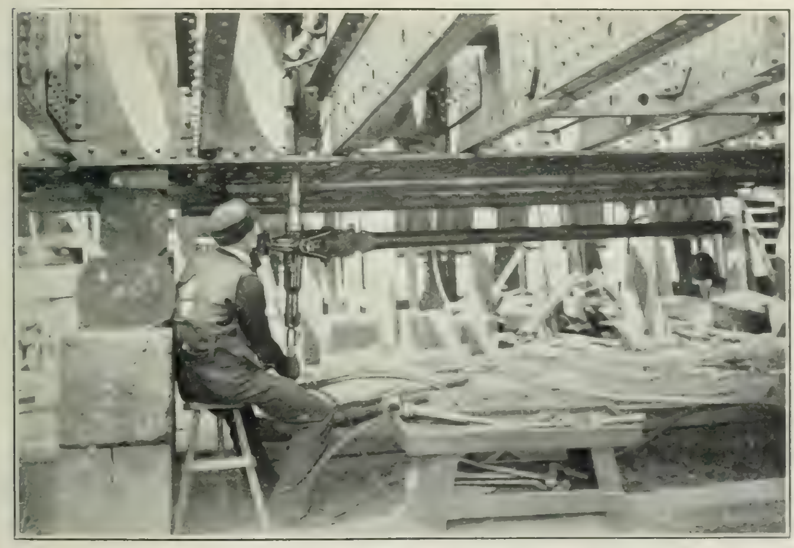


FIG. 63. PNEUMATIC SHELL RIVETTER AND HOLDER ON DRIVING RIVETS IN FLAT PLATE KEEL.

Courtesy of the New [illegible] Company

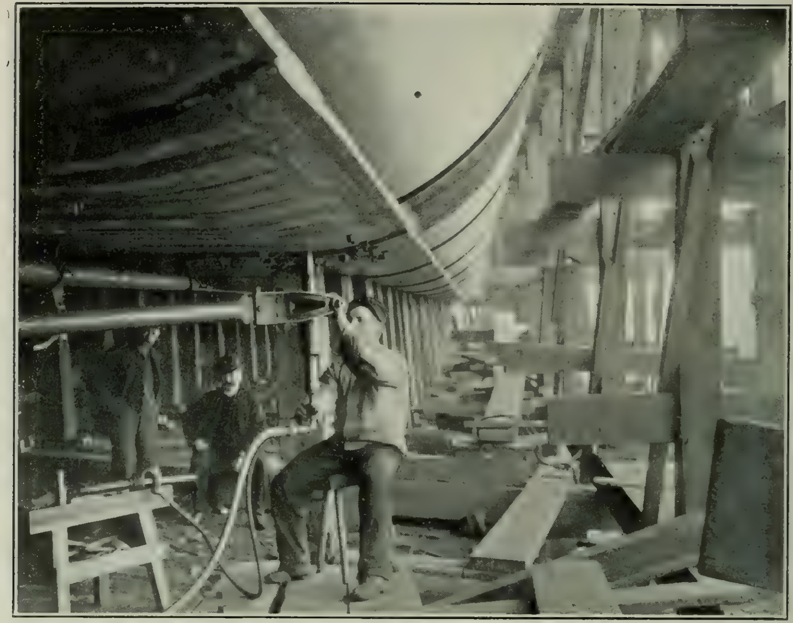


FIG. 64. PNEUMATIC RIVETTER DRIVING COUNTERSUNK RIVETS IN LOWER BILGE STRAKE.

New Taite Howard Company.

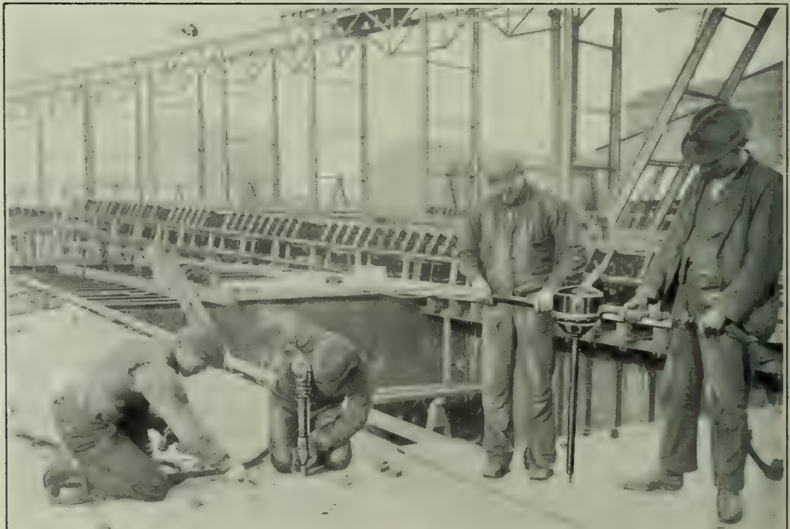


FIG. 65. PNEUMATIC TOOLS AT WORK ON DECK PLATING, CRAMP YARDS, PHILA., U. S. A.

Reaming, rivetting, and caulking with Boyer drill, long-stroke hammer, and chipping hammer.

Chicago Pneumatic Tool Company.

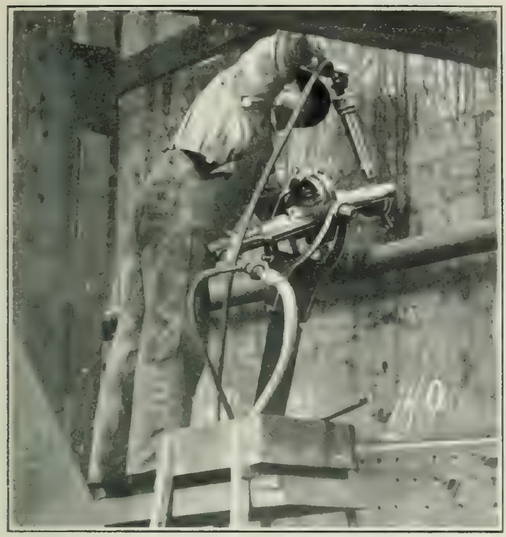


FIG. 66. SHELL RIVETTER DRIVING $\frac{7}{8}$-INCH COUNTERSUNK RIVETS IN SIDE OF SHIP. CUTTING OFF SURPLUS METAL WITH BOYER HAMMER.

terest and maintenance is not given, and is naturally much greater in machine than in hand work.

For chipping and caulking in engine and boiler work these tools have been used in this country for some time and have been found to work in every way satisfactorily, and their application to ship work is only a question of time.

For some of the other smaller operations upon the vessel while building, such as boring and punching, pneumatic tools may also be used with advantage. A convenient tool is shewn in Figure 68, which is an illustration of a large pneumatic drill. This drill can be easily reversed; and it is capable of boring a 3-inch hole in metal and is easily portable. Figure 67 shews this drill at work reaming the rivet holes in shell plating.

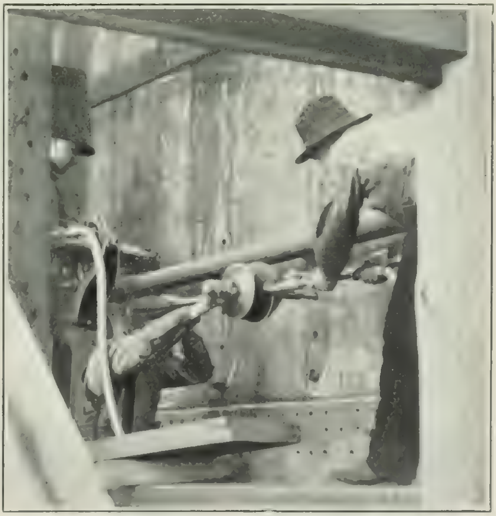


FIG. 67. REAMING WITH BOYER DRILL IN SIDE PLATING OF A SHIP.

At the present time a good deal of this work is done by electrically driven tools. A machine thus operated is a common type for drilling decks, and with slight modification the same tool may be used for any other part of the vessel, such as the shell bulkheads, etc. Figure 70 is an illustration of this tool. These tools can

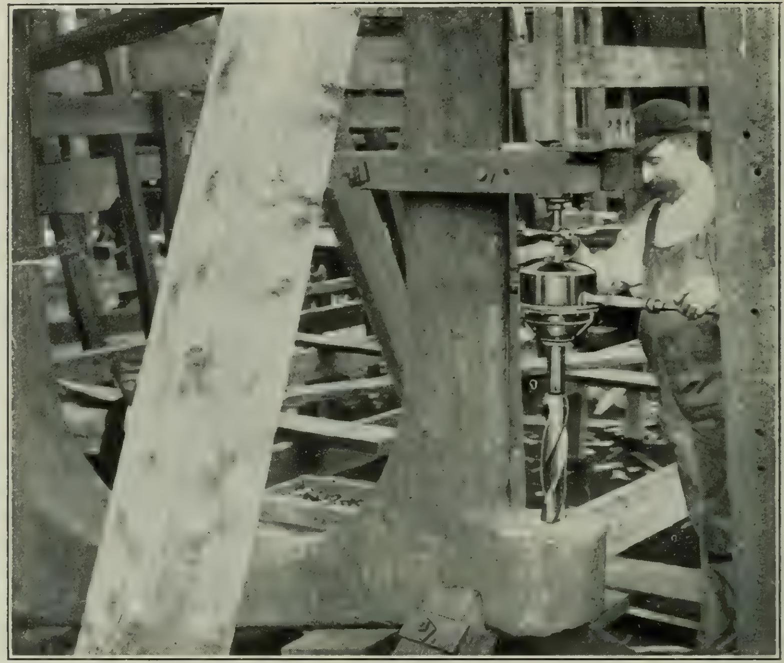


FIG. 68. PNEUMATIC TOOL DRILLING 3-INCH HOLE IN STEEL STERN-POST OF BATTLESHIP MAINE, CRAMP SHIP YARDS, PHILADELPHIA, U. S. A.

Boyer pneumatic drill. Chicago Pneumatic Tool Co.

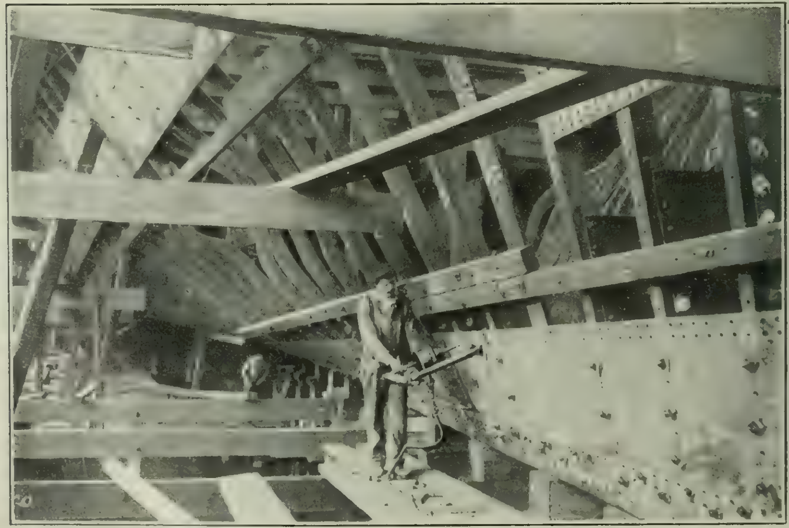


FIG. 69. DRILLING HOLES IN A SHIP'S HULL PLATING WITH PNEUMATIC TOOLS.

Boyer drill. Chicago Pneumatic Tool Co.

also be easily worked by a shaft joined to a motor by a universal coupling. The larger holes, such as sidelights, where formerly cut by hand, are now cut by a tool similar to Figure 72, driven either by hand or electrically; or, if a pneumatic installation is fitted, it may be adapted to this method of driving. Either of the latter forms of power may be applied to any other small machines used on the vessel, such as deck-planing machines, etc. (Figure 71).

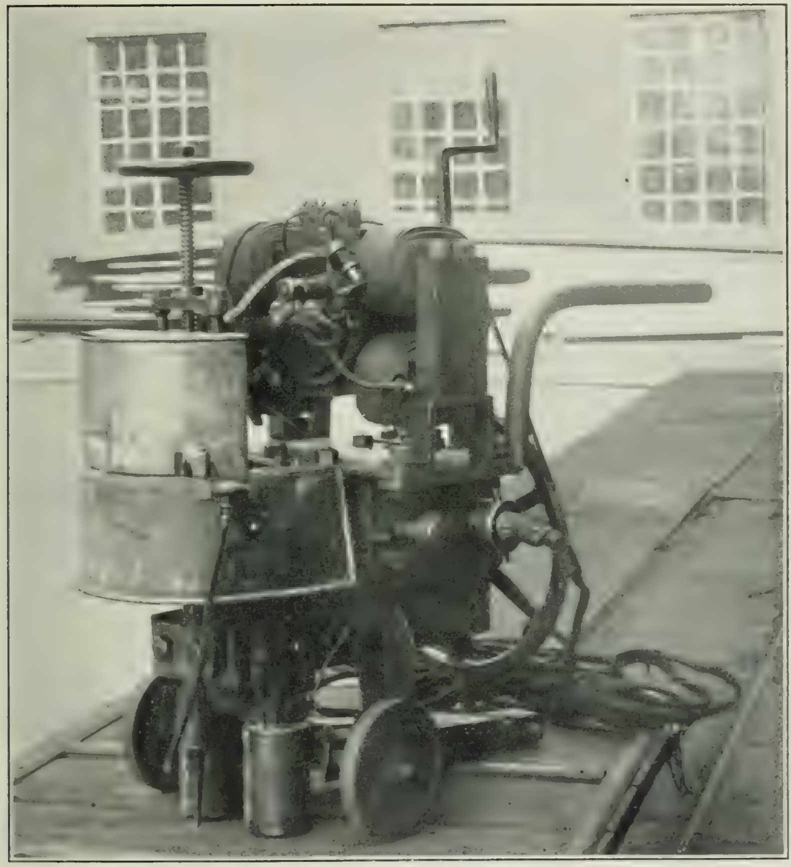


FIG. 70. ELECTRICALLY DRIVEN DECK-BORING MACHINE.

An essential point that should not be lost sight of in connection with all the machines already discussed is the one of upkeep. Independently driven machines, especially those in which steam is employed as the motive power, should be constantly attended to. In some yards it is the custom to employ a man whose sole duty is to test periodically every machine in use. Small steam engines, such as those used for driving punching machines, etc., are in any case not very economical and usually receive little or no attention, whereas if constantly tested any small defects can be immediately remedied and perhaps not only the life of the machine prolonged, but a saving in the coal bill effected.

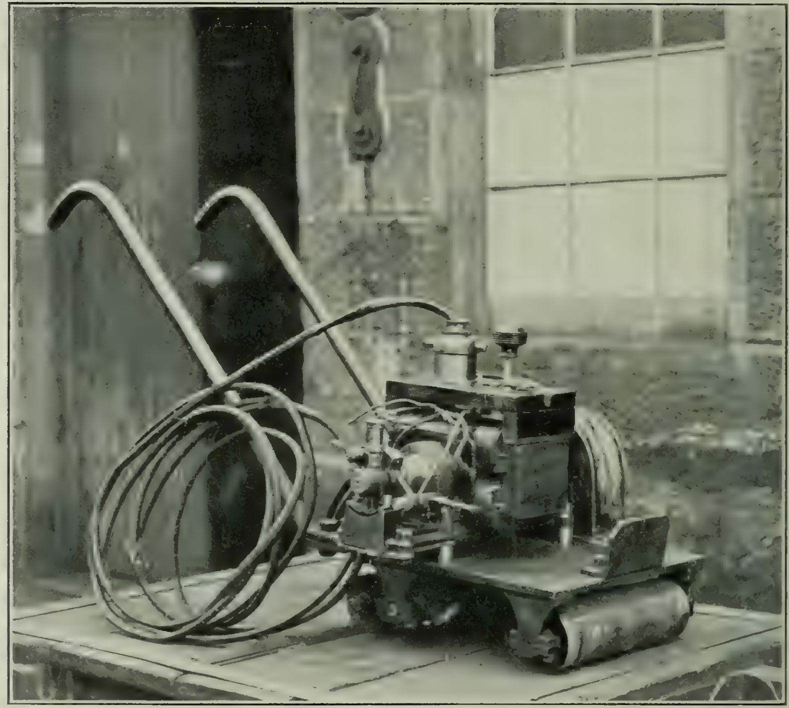


FIG. 71. ELECTRICALLY DRIVEN DECK-PLANING MACHINE.

It is not uncommonly the case that engine shops which turn out the very highest class of work are run by old and inferior engines which the owners of the shops in question would not think of building for sale.

In considering the general subject of the cost of production of a ship, the question of the economic cost of construction is determined to a large extent by the character of the mechanical equipment and the relation of the design of the structure to it. The former has been already generally discussed in the description of the various machines and their arrangements.

The design of structure also naturally affects the cost of putting

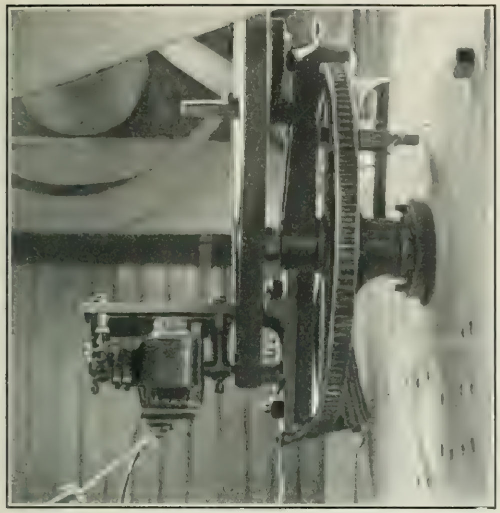


FIG. 72. ELECTRICALLY DRIVEN SIDE-LIGHT-CUTTING MACHINE.

the structure together, which structure, if made in too many pieces, will cause the work of connecting these parts to add to the cost of the vessel; while if it is made in too few pieces the parts cannot be economically handled, or will involve the use of plant of too expensive a nature for profitable production. Experience often teaches the sizes of different parts of the structure as far as these last-named two considerations go, but a knowledge of the limitations of the steel manufacturer in regard to sizes, as well as a knowledge of the limitations of ship-yard plant, is of great importance. Here we find two things clashing with each other, each very important in the economical production of a ship. On the one hand, the extra cost of workmanship due to having to get a larger number of parts together; on the other hand, the extra cost of machinery or plant (or, rather, the interest upon and depreciation of the extra cost of

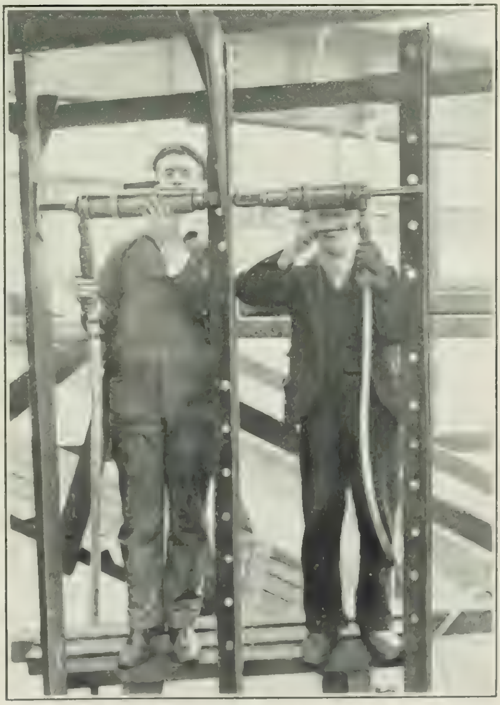


FIG. 73. BOYER DRILL AND PNEUMATIC HOLDER ON.

the plant) to enable larger pieces to be handled. This is a matter for estimating, but there is evidently a strong inducement to reduce the cost of workmanship by the adoption of machinery, when one remembers that one man's wages is equivalent to the interest on £1,000 of capital. It is also to be remarked that in addition to the saving on the cost of workmanship there is generally an increased output, due to the reduced time which the work takes to do. Take the case of outside plating. Twenty years ago 12 feet by 4 feet was about the normal maximum size of plating. Such a plate would weigh a little more than five-eighths of a ton, and it could be transported on a light barrow and hoisted by plating tackle by the men who were necessary to mark it and punch it. Plates are not uncommonly now used of more than double this length, and of breadth nearly half-as-much again, and of a weight of quite three times. The number of rivets per ton-weight of plate is one-fourth less in the large plate than in the small one. The adoption of such plates involves power cranes, iron railways, and much heavier plant generally. Instead, however, of being able to turn out a ton of ship-building, we should now be able, with the same amount of workmanship and with this improved plant, to turn out more than one-and-a-third tons, a gain of

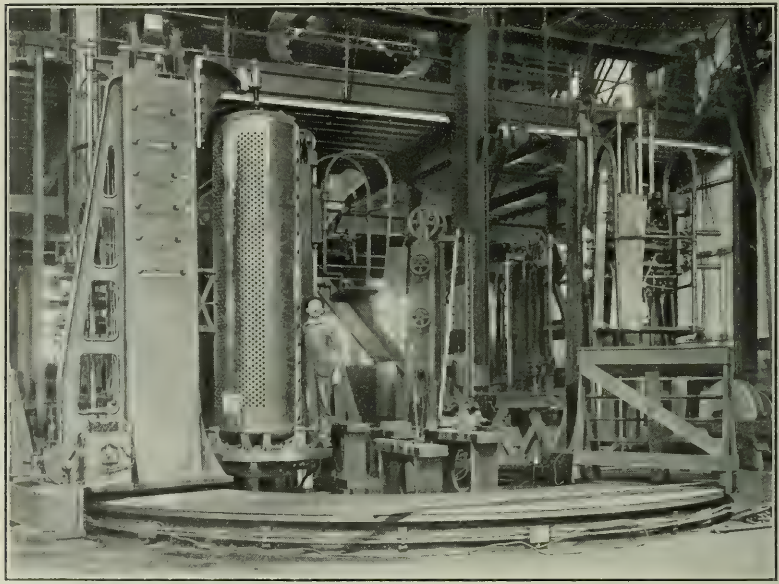


FIG. 74. DRILLING DRUM OF THORNYCROFT BOILER FOR TORPEDO-BOAT DESTROYERS, WITH ELECTRIC-DRIVEN TOOLS, UNION IRON WORKS, SAN FRANCISCO.

33 per cent. in output. Increase of plant cannot go on indefinitely, and therefore it is evident that there will be some point at which increase of plant cannot be associated with increase of size of pieces which go to make up the structure, because of the limitations which the steel manufacturer has placed upon him.

The same kind of considerations apply to a great many parts of the equipment of the ship. There is also the simpler question of direct displacement of manual labour by machine labour to do the same work because of its greater rapidity and its less cost. Drilling, caulking, rivetting, are operations which have undergone this change. A ship's structure cannot be made without machines. The type of the machine

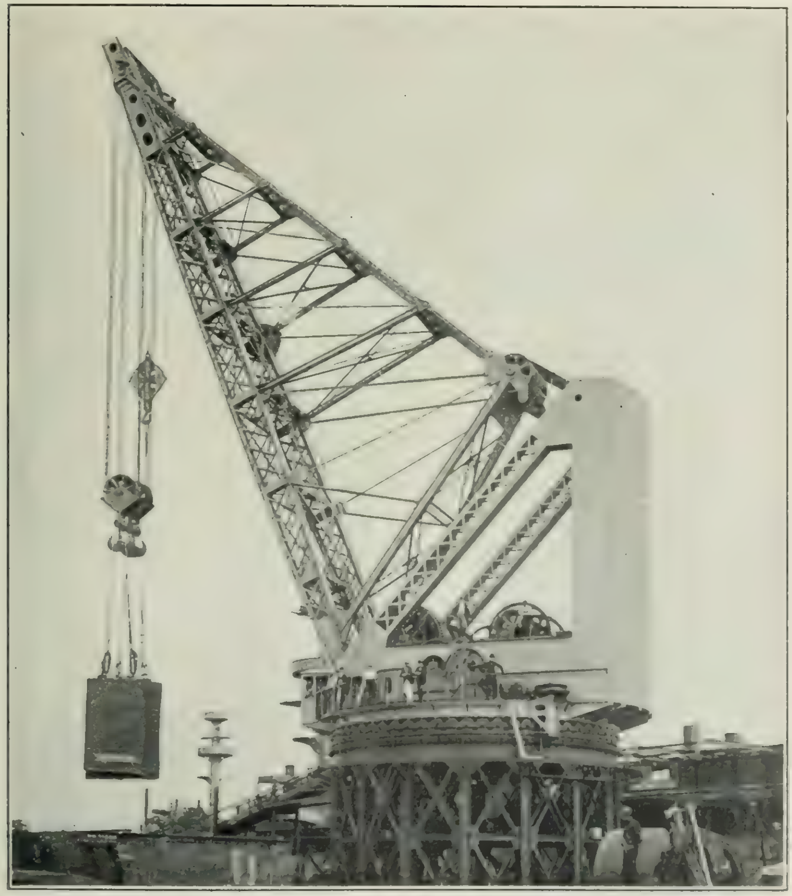


FIG. 75. 150-TON REVOLVING DERRICK, ELECTRICALLY OPERATED, FOR INSTALLING HEAVY WEIGHTS ON BOARD VESSELS, SEATING ARMOUR PLATES, ETC.
Newport News Ship-Building and Dry-Dock Company, Newport News, Va., **U. S. A.**

is determined by the structure, and the structure depends upon the machines that are to make it, so that these two things act and re-act upon each other, and the ship-builder therefore requires to be familiar with the science of the arrangement of the ship's structure, and he has to be familiar with the science of machinery which is to make that structure. The cost of production depends upon the design of the structure and upon the method of putting it together. The design is moulded by the ship-builder to fulfil the two requirements—(1), what the structure has to do, and (2), how it is to be put together. Of

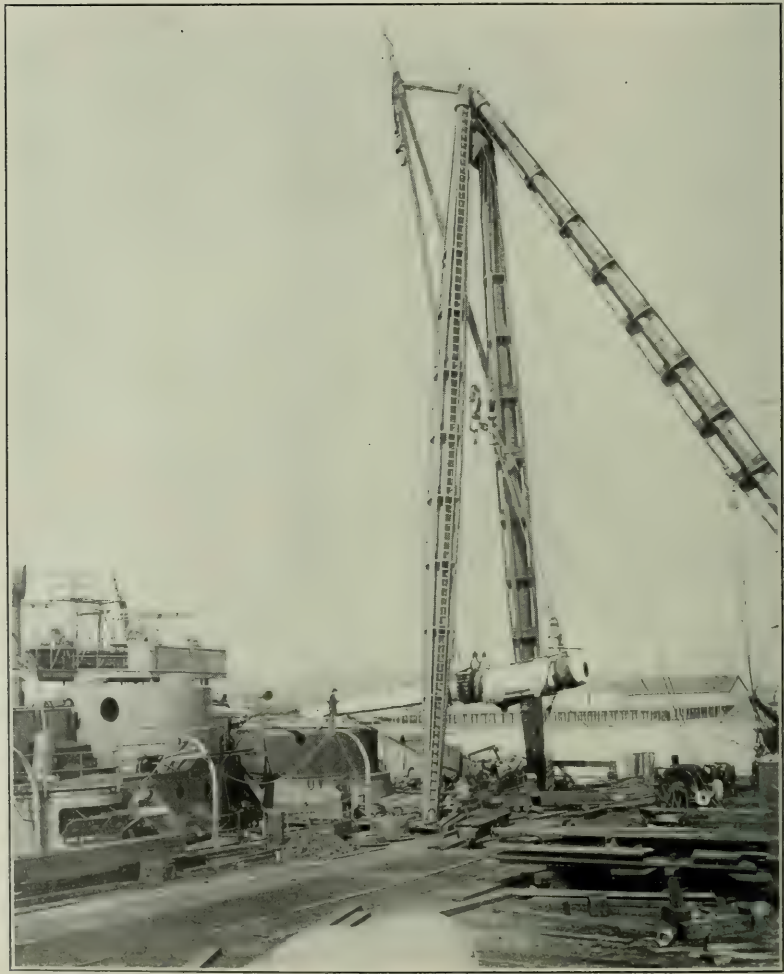


FIG. 76. PLACING 13-INCH GUN ABOARD U. S. S. OREGON AT THE UNION IRON WORKS, SAN FRANCISCO, U. S. A.

course, there are a great many things that go to make up the cost of a ship which do not contribute to the main structural strength. In fact, many of them will involve a greater strength of structure than would be necessary without them.

The handling of material may be generally divided into two parts: (1), transporting while being subjected to the various processes incidental to its manufacture, and (2), erecting and finally fitting in position in the vessel. Both of these items have a very important bearing upon the cost of production. The economy of using as large plates as possible has already been discussed from a general point of view, but in most cases there is a certain limit beyond which any increase in size, and hence in weight, is accompanied by such increased difficulties in handling as to render any further economy very small, and perhaps the nett economy even less than with the smaller plates. The cost of building in the largest types of ships with the ordinary appliances is usually greater per ton-weight than in the smaller types. Up to a certain limit, say to about 6,000 tons, the cost per ton, as is only to be supposed, decreases; but above this the greater weight of the individual members, such as frames, beams, etc., and the greater heights to which all weights must be lifted, as well as the increased difficulties of keeping the whole structure fair while building, lead to increased expense in handling. This is largely due to the fact that sizes of ships have grown more rapidly than the power of the plant for handling the material of construction. A plant which may be efficient for a certain size of ship may be inefficient for a larger one.

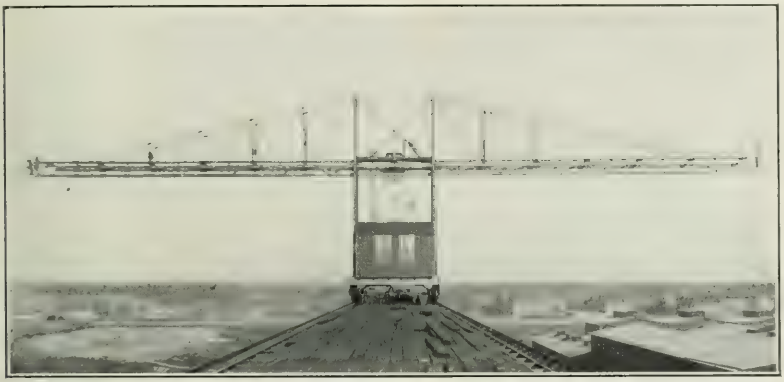


FIG. 77. ELECTRIC TRAVELLING CANTILEVER CRANE, HANDLING 9,000-LB. WEIGHTS OVER A REACH OF 89 FT. ON EACH SIDE, AND 25,000-LB. OVER A REACH OF 55 FT. ON EACH SIDE.

Travels over a trestle 735 ft. long and 78½ ft. high, with building ways on both sides. Newport News Ship-Building and Dry-Dock Company.

The nearer the capabilities of a manufacturing establishment approach their limits, the more likely are insufficiencies to shew themselves and the cost of production to be thereby increased.

We have already seen the operations that the steel material undergoes in the general process of preparing it for its final position in the ship. The order and nature of these operations and the methods of handling the material have also been discussed.

A great deal of importance attaches itself to the arrangement of and method of stowing the material as it comes into the yard ready for the operations above mentioned.

The necessities of convenience, proximity to the machines, methods and order of working the different parts, the arrangement of material when stored and the appliances for shifting and transferring the parts --all have been considered in the question. For convenience and for classifying the material according to the nature of the first operations on it, it is often stored in two or more places.

Near the furnaces it is convenient to have an open space in which to lay down those parts which have to be heated or shaped at the boards, *viz.,* floor plates, bulkhead plates, frame angles or bars, etc. Shell plates, deck plates, inner-bottom plates, and casing plates, etc., are all stored in a rack or laid out together in a certain way. The method of stowage depends largely on the amount of space available. For occupying the least space, the plates should be stored on edge; but the best way when there is plenty of room is to lay out the plates horizontally, in groups, according to the order in which they are worked. The most common arrangement employed in yards for shifting the material is to have an "in" line down one side of the rack for plates, and an "out" line leading to the yard machines down the other side. Sometimes a traveling gantry is constructed so as to run over and embrace the plate rack and two lines of rails, or one or more travelling jib cranes running on the railway line are employed for lifting or transferring the material. The above method of having an "in" line on one side, and an "out" line on the other is to enable the plates to be put in at any place from the "in" line and to be withdrawn from any place to the "out" line. At the yard end of this plate rack or store, in a yard where war-ships are built, is a pickling trough for the purpose of removing the scale from the plates. For handling the material stored near the furnaces, one line of rail is sufficient and a travelling jib crane is commonly employed. There are definite ways of laying out or storing the material. The ordering of the material from the drawing office is arranged to suit the order of construction, so that generally as the material comes in to the yard it is laid down in the order in which it comes in. The frames, as soon as they are laid down, have work started upon them provided the scrive boards are ready; then other parts follow in a definite order, so that by experience places for the different parts are allotted. Beams, angle bulbs, stringer bars, etc., are usually emptied from the trucks in to an open space near the bending machines or beam shed, where they are picked up and immediately dealt with.

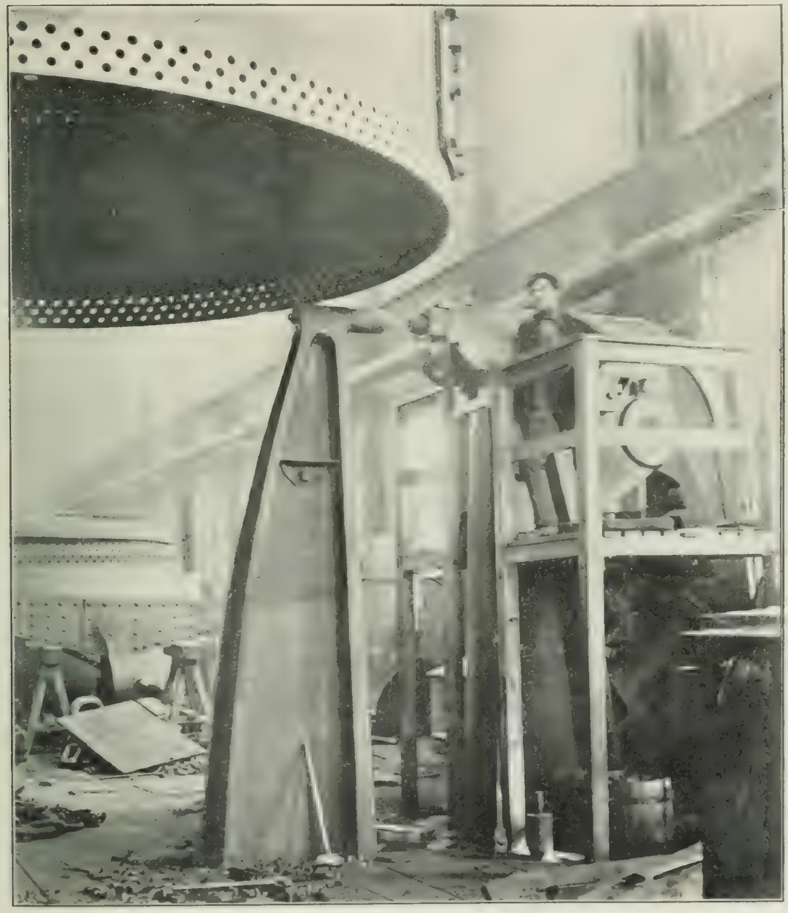


FIG. 78. HANDLING HEAVY PARTS IN THE SHIP-YARD. A LARGE-SIZE SCOTCH BOILER SUSPENDED AT THE HYDRAULIC RIVETTERS, NEWPORT NEWS YARDS.

There is also another rack in which spare plates and angles are kept in stock, though it is the aim of every economical manager to have as little of this as possible and to avoid it by ordering to required sizes. The removal of material from one place to another is performed in many ways. Perhaps the most common is to lay a light railway to all parts of the yard, and upon this to run small cars capable of taking any piece, the cars being propelled by hand. This method is suitable for the transport of a number of the smaller parts, but for the heavier parts, small locomotives, or better, locomotive cranes, will save time and expense in the long run. Take for example a large shell plate. This has first to be removed from the store to some place near the punching and shearing machines. It has then to be lifted by the small cranes attached to the punching machine, and some holes punched from one side and some from the other. It has then to be removed in succession to the shearing machine, the planing machine, plate-bending rolls, sometimes to the plate-straightening rolls, and finally to the countersinking machine. Between each two of these operations the plate has usually to be placed upon some form of barrow and removed to the next machine, and the same process followed throughout. All this, if carried out by hand, involves the use of a number of men and a considerable amount of time, the time expended in handling and the number of men employed varying approximately with the size and weight of the plate. When it is remembered that in a large vessel over one thousand plates in the shell and decks are handled in this manner, it is obvious that anything that can be done to save time during each of the above operations will amount to a considerable saving over the whole ship. From these observations it is evident that all machines for each part of the structure should be placed as closely together as practicable, and if possible so arranged that the cranes of one machine are capable of taking, say, a plate from the machine immediately preceding and passing it on to the following machine. This is not always possible, and perhaps a better method is to fit one or more quick-running travelling cranes over the whole shop or shed, so that the piece may be readily and quickly transferred from place to place. Another method is to support the piece from a runner travelling along a rail over the place where the material has to be shifted. If the store is so arranged that the crane from that part will place the material so that it may be readily picked up by the crane in the machine shop, the whole process of working will be subjected to the minimum amount of manual handling; also, if the final machine is placed as near as possible to to the building berths, and the other machines are placed in their proper order, the piece will in the course of its manufacture be always approaching its final position on the ship.

The second part of the handling process, i. e., hoisting and depositing materials at any point of the ship, is managed in numerous ways. The oldest method was by means of a derrick or pole, four or more, depending upon the size of the vessel, being placed in convenient positions and worked by steam winches. Latterly hydraulic derricks have been used in many situations. A hydraulic jigger or ram is attached to a tall mast which is fixed into the ground; on this mast at a convenient height swings a derrick arm. A wire rope passes from a pulley on the jigger and is led up along the derrick. Another method, which is in use at the Newport News yard, and has already been described in a number of periodicals, is by means of a cantilever travelling crane. A third method, and one used in the construction of the "Oceanic" at Messrs. Harland & Wolff's, is to have a large travelling gantry running on rails at each side of the vessel for a part of its length. Figures 79 and 80 shew this contruction. A fourth method is that of a framework which is capable of supporting travel-

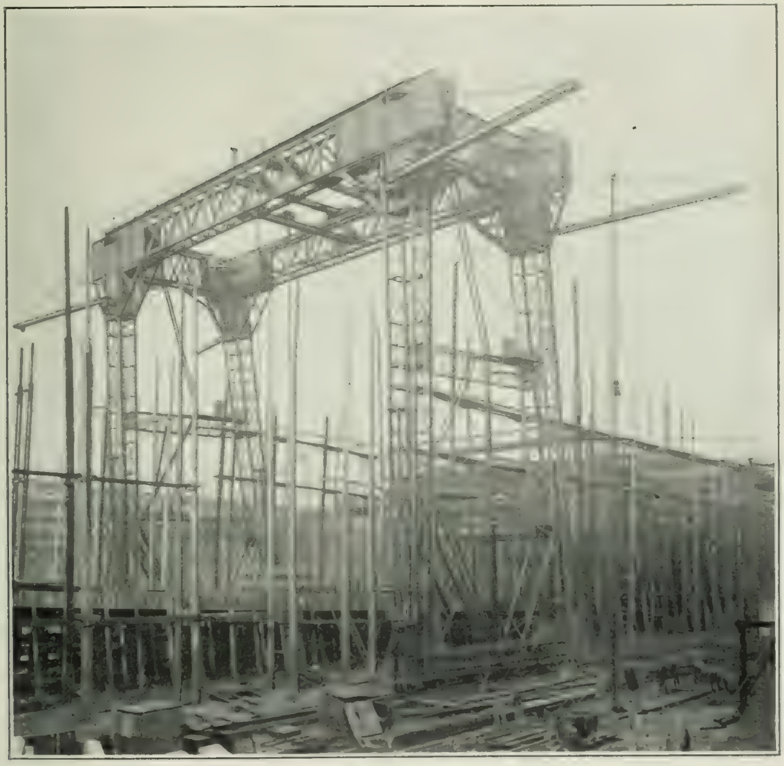


FIG. 79. HARLAND & WOLFF'S TRAVELLING GANTRY.

ling and other cranes, built over the entire length. Of all methods this is best, as it fulfils more than the one condition of hoisting and depositing material. It is shewn in Figures 81 and 82. Now that power rivetting is so much in use, and is likely to increase, the demand for something upon which these machines may be carried and moved from place to place is imperative. The travelling gantry is almost essentially a machine for this purpose, but while it is in use for these machines, it cannot be used for hoisting, or at any rate only to a limited extent. The shed or framework over the whole vessel, besides carrying one or more travelling cranes capable of depositing materials at any point in the ship, may also be fitted with separate cranes at various points, which support all the necessary rivetting or other machine tools independently of the overhead cranes. The method adopted is to support a bar of ⊥ section between the side cranes and upon this to mount the machine tools, these being slung upon wheels of large diameter running in the flanges of the ⊥ bar, so that the machine may be moved with as little labour as possible. This structure also fulfils another very important condition, in that its sides form supports for the necessary staging round a vessel which, when made of wood, is in itself a considerable item in the cost. It also forms a good means of support for the various stays required to keep the vessel fair in the earlier

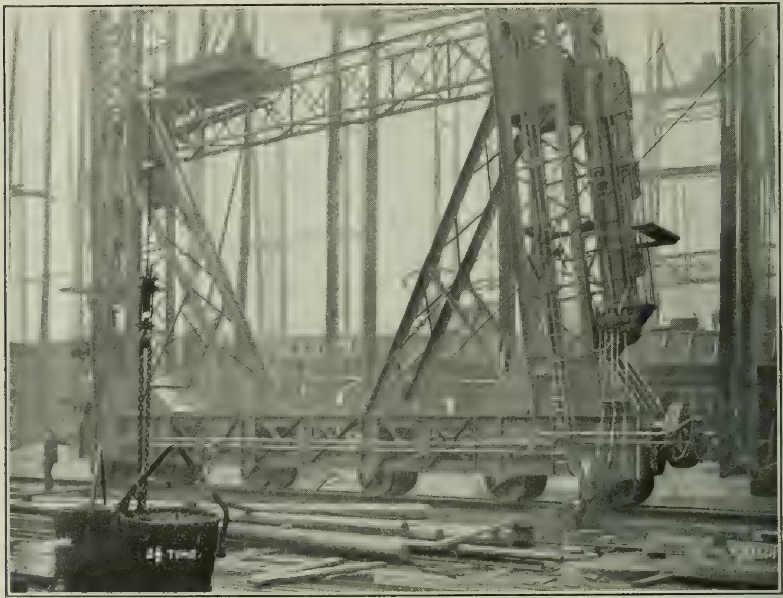


FIG. 80. HARLAND & WOLFF'S TRAVELLING GANTRY. VIEW OF THE BOTTOM OF ONE LEG.

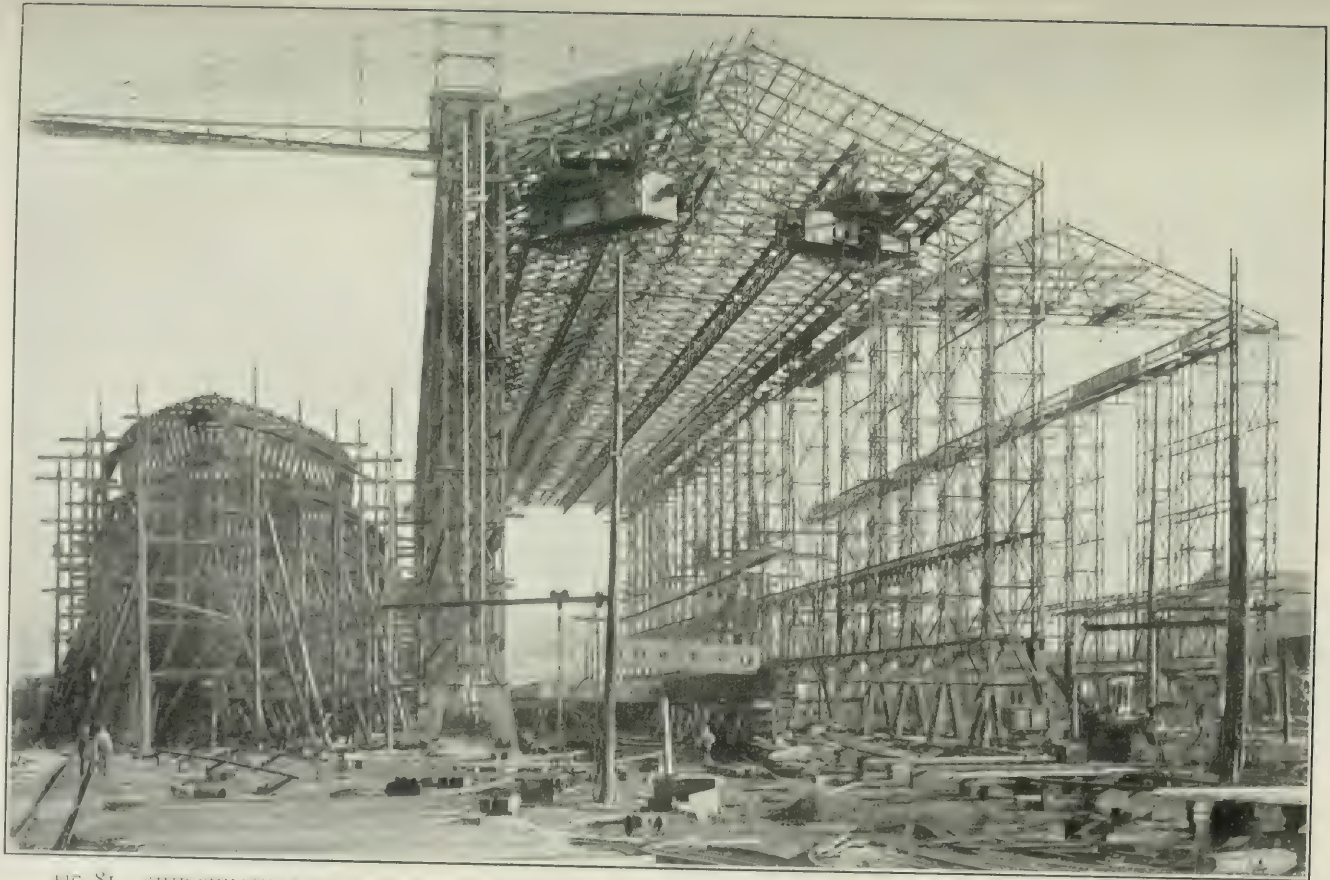


FIG. 81. SHIP-BUILDING SHEDS WITH OVERHEAD CRANES, YARDS OF C. C. SWAN & HUNTER, WALLSEND, NEWCASTLE-ON-TYNE.

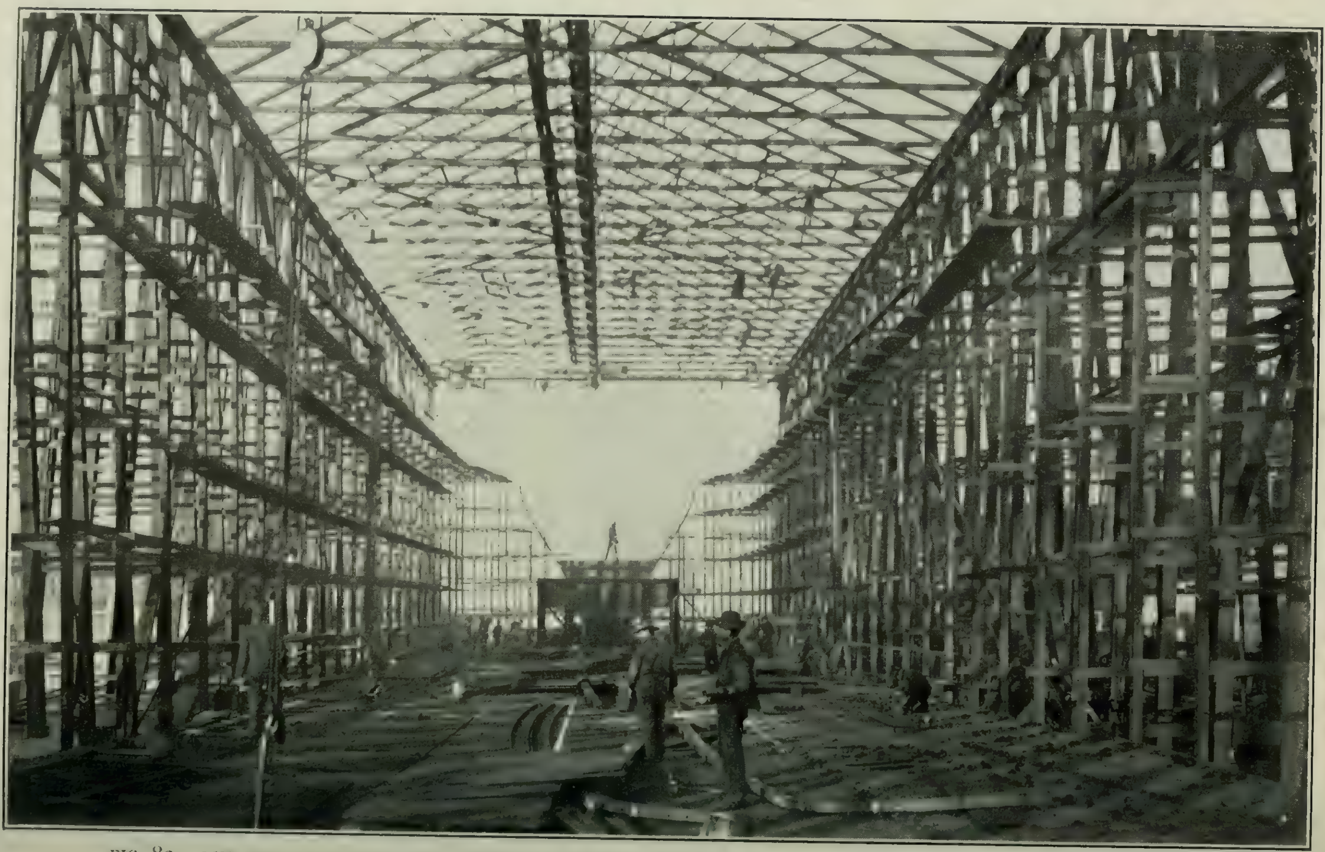
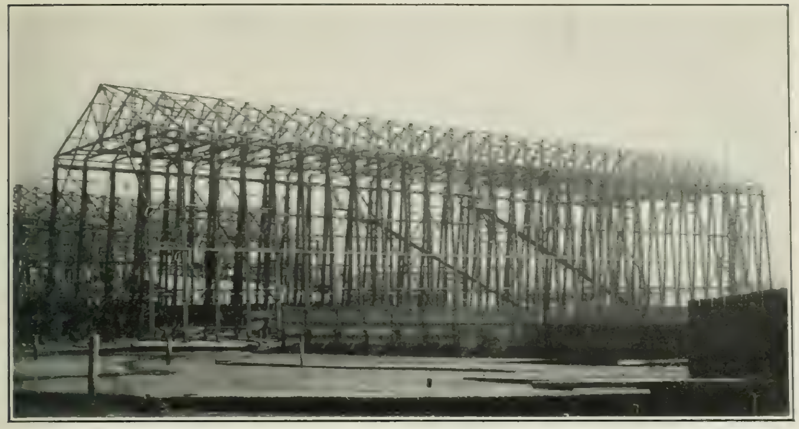


FIG. 82. BUILDING SLIP WITH TWO OVERHEAD TRAVELLING CRANES, UNION IRON WORKS, SAN FRANCISCO, U. S. A.



GENERAL VIEW OF SHIP-BUILDING SHED, UNION IRON WORKS.

stages of construction; this also being an important factor in large ships. Finally, if roofed in, as it may readily be, it forms a shelter against the weather, thereby enabling a much greater amount of work to be done in a given time and all work to be done with much less discomfort. Two cranes may be mounted at each end and used for any lifting purpose or, for example, at the fore end for mounting the machines for rivetting frames and floors.

The first cost of such a structure is no doubt a considerable amount, but the advantages enumerated above will make themeselves felt in a very short time by the decreased cost of production and increased rate of output. If the building berth be in a direct line with the machine shops, overhead cranes may be run from the shops right over the ships.

The foregoing is a brief sketch of ship-building equipment as it has been developed in Britain. Many changes have been made from time to time, as necessity has compelled, but no doubt many more can be made with advantage; and when American ingenuity and boldness has had a few years more development in building large ships, the equipment of a ship-yard will be probably very different. One of the boldest attempts in this direction has been made under the guidance of Mr. Morse in the New York Shipbuilding Coy., of Camden, and the experiment of the most costly labour-saving ship-building plant that the world has ever seen will be watched with the keenest interest. Whether it is before its time, time only will shew; but its full development cannot fail to be of service to the United States, and it is most sincerely to be hoped that it will not be left to a later and more fortunate set of proprietors to profit by the skill and ingenuity shewn.

PHYSICAL AND ECONOMIC FEATURES OF THE UGANDA RAILWAY.

By Frederick W. Emett.

The Uganda Railway is typical of the great engineering undertakings by which England has made highways of civilisation in the darkest regions of the earth. It has special interest on account of its near approach to completion, and its importance in the general scheme of railway development which will proceed with new stimulus as soon as settled conditions are restored in South Africa.—THE EDITORS.

It should be stated at the outset that in preparing this article for THE ENGINEERING MAGAZINE I do not propose to confine myself to a recital of mere technical statistics and details, but rather to give—as far as is possible within space limits—a comprehensive and general account of the Mombasa-Victoria Nyanza Line, more generally known as the Uganda Railway, an undertaking which it seems to me stands as a monument to British enterprise and endurance in what was once known as savage Africa—a title which is fast becoming obsolete.

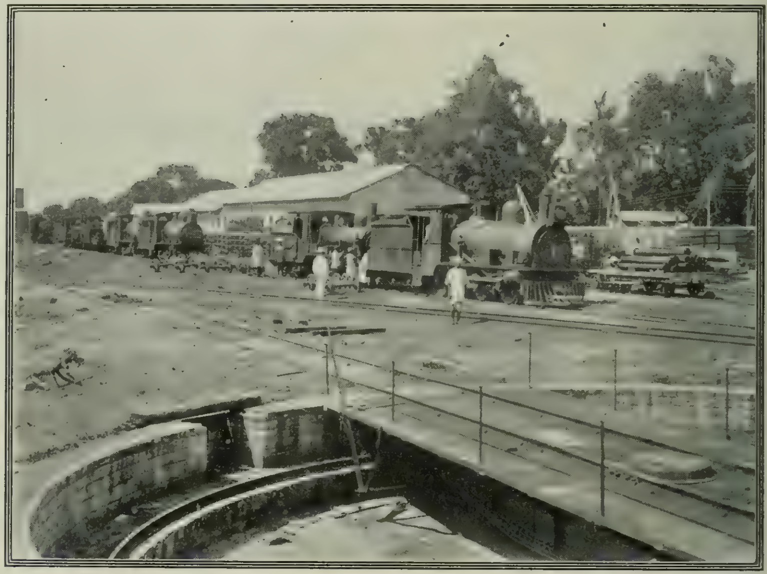
At the moment of writing (March, 1901) I read the following despatch from East Africa: "Nearly 500 miles of this line are completed. Soon the lakes will be won and the weary strain over. Wild beasts, wild men, and a wild country have been the foes who have been ably assisted by such auxiliaries as sickness, famine, drought, and loneliness unspeakable. The unknown will soon be an open book to the weakest and most frail." The question of the construction of a line from the East African coast to the shores of Lake Victoria was first mooted in the time of the British East Africa Company, and after a number of railway experts had been consulted the first reconnaissance survey was commenced at the end of 1891. Other surveys followed and maps and plans were prepared, but it was not until August, 1895, that the British Government decided upon the construction of the line. It was settled that the Government would itself do the work and in December, 1895, Mr. Whitehouse, the chief engineer, arrived with his staff at Mombasa.

GREAT SALISBURY BRIDGE, CONNECTING THE ISLAND OF MOMBASA WITH THE MAINLAND, COAST TERMINUS OF THE UGANDA RAILWAY.

The old temporary wooden bridge is shown on the right.

In January, 1896, actual operations commenced and it is hoped that the end of the present year will see British and American locomotives steaming into the station at Port Florence, the terminus of the line, 580 miles from the sea, in the very heart of Africa—surely no mean record for the British engineer! Without taking into consideration the difficulties to be overcome, critics have complained that six years has been an unnecessarily long period for the completion of the work, and as a matter of fact, enquiry was instituted by the Government, who sent out Sir Guilford Molesworth (one of the railway authorities originally consulted with regard to the proposed line) to report, and he stated after exhaustive examination on the spot that the rate of construction had, on the whole, been maintained in a manner highly creditable to the chief engineer and the officers concerned. The various criticisms which have appeared practically ignored three very essential facts: (1), that the country is sparsely inhabited, and that the native of the country will not work even under stress of famine: (2), that water is generally bad, and only obtainable at long intervals: and (3), that animal transport over the first 250 miles from the coast—the "tsetse fly region"—is impracticable, and that porters have to be used.

The first work of the railway party was the establishment of a coast base for the line, Mombasa having been the spot selected, and the erection of the necessary landing stages, piers, sheds, stores, and dwelling houses was immediately commenced. Simultaneously with the establishment and organisation of the base a survey was made for the route to be followed to the crest of the range of hills near the coast, there being a rapid rise in the first 20 miles to be traversed by the railway. While this work was in progress a party was sent on to Kibwezi, nearly 200 miles up country, to work backwards and eventually to join up with the party working from the coast. The business of the last-named section was to make a detailed examination of the route, to stake out the line for the working parties following behind, and to draw up the necessary working plans. A third party was despatched 400 miles up the road to Kikuyu to ascertain the best route for the railway across the main escarpment of the Great Rift Valley, where some of the most difficult engineering was to be expected. At the end of 1897 the first and second parties joined hands, and together proceeded to the point where the third and advanced party had commenced its work. The advance section, which had the most difficult task, completed its labours in April, 1900.

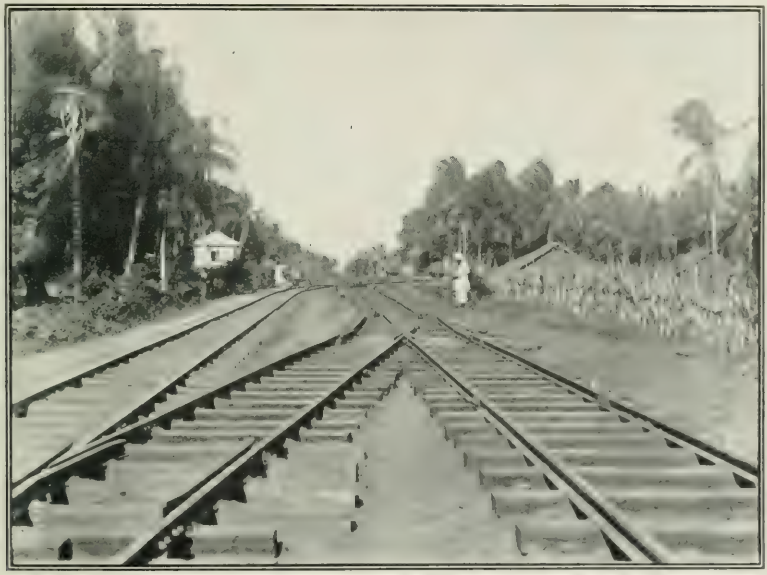


STATION YARD AT KILINDINI, THE COAST TERMINUS.

The difficulties encountered by each of these parties were of great but varying intensity. Not only in the earlier days, but right through the period of construction up to the present time, the engineers have had to face one long series of obstacles, not only from the physical and climatic conditions but also from a series of native risings, from famine, and from wild beasts. When the first engineering party stepped ashore at Mombasa they were immediately confronted by a local rebellion which necessitated strong guards being placed over isolated camps

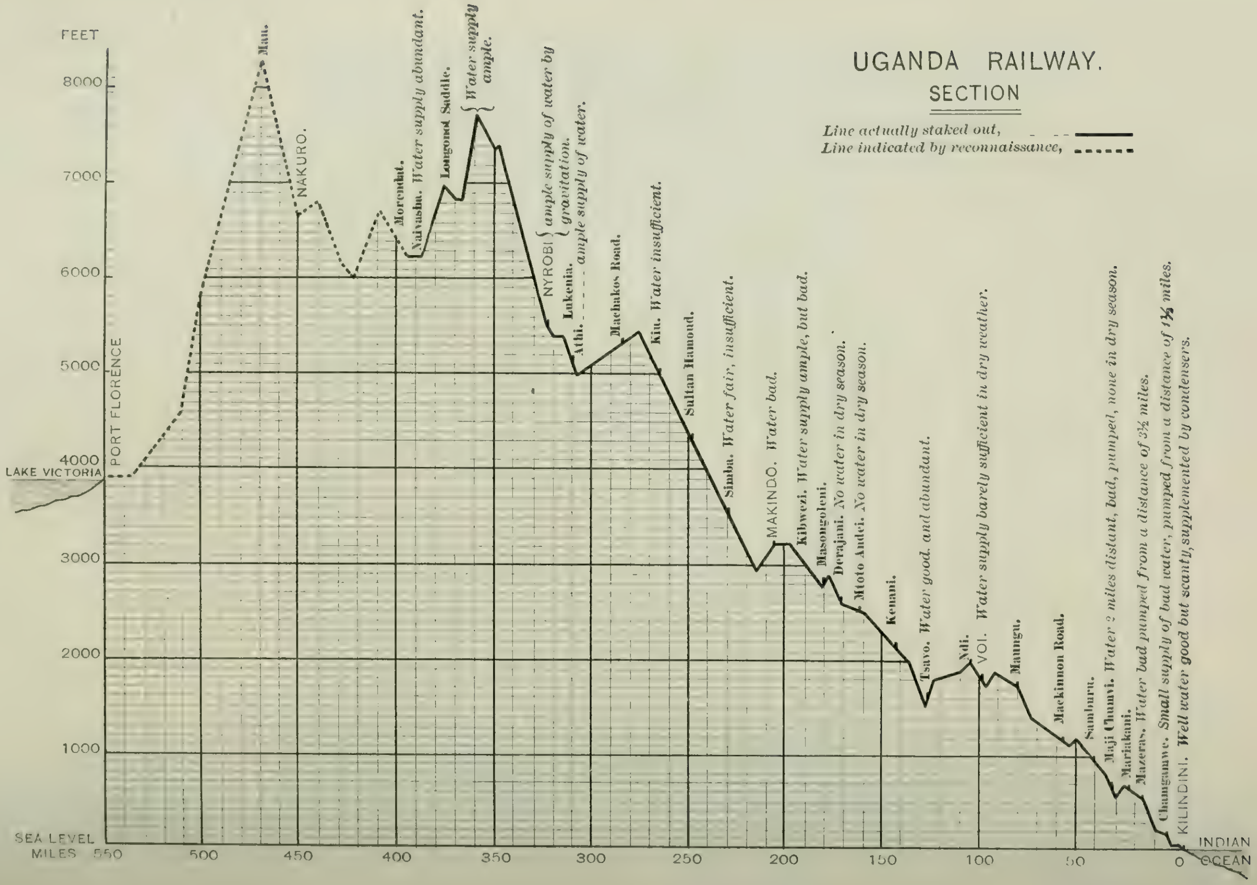
—a very difficult matter, as the troops were needed for operations against the natives and were not available for the protection of the railway works.

Perhaps one of the greatest problems that had to be faced was that of the supply of labour, which not being available in the country had to be imported from India. Sir Guilford Molesworth states that the construction of the Uganda Railway involves an organisation equivalent to the maintenance of an alien army, amounting to over 20,000 men, in a practically waterless country, devoid of resources and of all means of animal and wheeled transport. Even at the advanced workings, hundreds of miles in the heart of Africa, everything had to be imported from a distant country, and from railhead to the advanced parties all stores, etc., had until lately to be carried on men's heads.



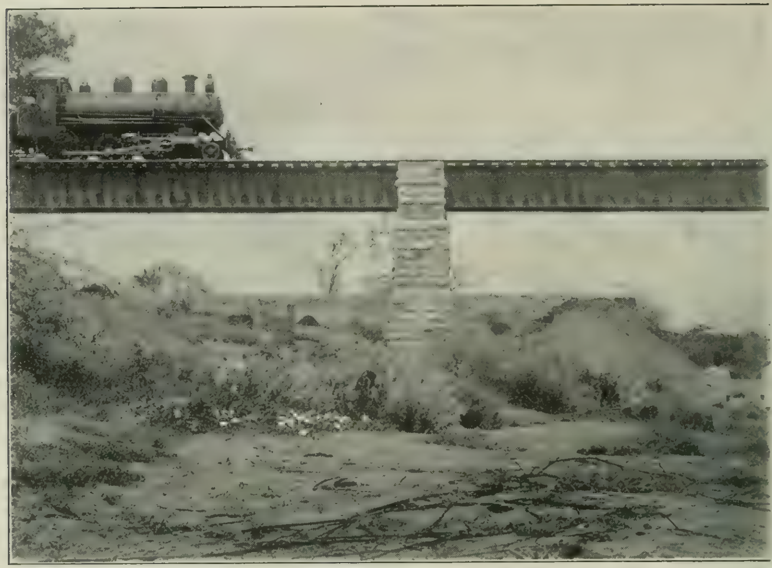
A STATION AND SIDINGS FOUR MILES FROM THE COAST TERMINUS.

Apart, too, from the engineering difficulties, which I will deal with later, the scarcity of water greatly hampered the work; while the depredations of man-eating lions, necessitating the erection of special stockades for the protection of the Indian coolies' camps and involving the death of two officials and about thirty coolies, the prevalence of fever, "jiggers," and ulcers and sores due to the thorn bushes through which the men had to cut their way, and many other untoward circumstances—these constitute a list of difficulties which ought to be sufficient answers to critics who complain of the time occupied.


UGANDA RAILWAY.
SECTION
Line actually staked out,
Line indicated by reconnaissance,
FEET
8000
7000
6000
5000
4000
3000
2000
1000
SEA LEVEL
MILES
550
500
450
400
350
300
250
200
150
100
50
0
LAKE VICTORIA
PORT FLORENCE
Mau.
NAKURO.
Morendat.
Naivasha. Water supply abundant.
Longonot Saddle.
Water supply ample.
NYROBI ample supply of water by gravitation.
Lukenia.
Athi. - - - - ample supply of water.
Machakos Road.
Kiu. Water insufficient.
Sultan Hamoud.
Simba. Water fair, insufficient.
MAKINDO. Water bad.
Kibwezi. Water supply ample, but bad.
Masongoleni.
Derajani. No water in dry season.
Mtoto Andei. No water in dry season.
Kenani.
Tsavo. Water good, and abundant.
Ndi.
VOI. Water supply barely sufficient in dry weather.
Maungu.
Mackinnon Road.
Samburu.
Maji Chumvi. Water 2 miles distant, bad, pumped, none in dry season.
Mariakani.
Mazeras. Water bad pumped from a distance of 3½ miles.
Changamwe. Small supply of bad water, pumped from a distance of 1½ miles.
KILINDINI. Well water good but scanty, supplemented by condensers.
INDIAN OCEAN

To turn to the engineering difficulties, a glance at the profile of the line shows generally that from the coast terminus there is an almost continuous rise to Kikuyu, 350 miles from the sea. In the first 60 miles the line reaches an altitude of 1,200 feet at Mackinnon Road Station, and goes steadily upward until just before reaching Voi (100 miles) 1,800 feet is reached. Thence there is a drop of some 200 feet at the Tsavo river (130 miles), from which point there is a continuous up-gradient to Makindu, where at mile 205 the altitude is over 3,200 feet. Proceeding towards the lake, a sharp drop for 20 miles brings the line to the foot of an incline which extends to mile 280, where Machakos Road Station has been build at an altitude of 5,500 feet. Nairobi (mile 345), the headquarters of the line, is at practically the same level as Machakos.

Beyond Nairobi the line mounts to the Kikuyu escarpment (mile 360) at a height of 7,800 feet. Then commences a descent of nearly 2,000 feet in the Great Rift Valley, followed by a precipitous climb until at the Mau summit (mile 490) the line reaches its highest level of 8,300 feet. The remainder of the railway to Port Florence, the terminus on the Victoria Lake (mile 580), is a continuous drop to the lake-shore level of 3,800 feet. The Great Rift Valley, which I have referred to, extends for several hundred miles and the descent into and ascent out of this valley and descent again towards the lake were the difficult problems in the construction of the railway, so far as the physical features of the country are concerned. For 200 miles from the coast terminus the "tsetse-fly belt" extends, and in this zone, which is covered with dense thorn, no beast of burden can live. In the Kikuyu and Mau districts primeval forest and almost impenetrable undergrowth rendered the progress of the work extremely difficult. In a recent paper before the Royal Engineers at Chatham, from which I have been permitted to extract a large number of technical details, Mr. F. L. O'Callaghan, the energetic managing member of the Uganda Railway Committee at the Foreign Office in London, said that the ruling gradient for the coast section of the line was 2 per cent. with 10-degree (573-feet radius) curves as a maximum, and that the same ruling gradient has been used over the Kikuyu and Mau ranges but in combination with 7-degree (816-feet radius) curves. He added:—"Wherever the permanent working section showed heavy earthwork, which could not be completed in time to allow of the rails being laid over them, temporary lines, or 'diversions,' were marked out with gradients as steep as 3 per cent. and curves of 14 degrees. On the first portion of the railway up to Nairobi there are no less than



THE BRIDGE AT TSAVO.

The engine is American built.

40 miles of diversions, while on the remaining portion of the line these temporary lines will not fall short of 44 miles. Many of these temporary works were of considerable magnitude; the first of these was the temporary bridge connecting the island of Mombasa with the mainland, while every river and ravine met with had to be temporarily crossed by bridges constructed of sleepers and girders. Many other temporary structures—such as stagings for water-tanks, etc.,—were required." The first engineering difficulty encountered within two miles of the coast terminus of Kilindini was the crossing of the Macupa strait, an arm of the sea dividing the Island of Mombasa from the mainland. The original scheme was that this should be done by means of an embankment, but as the channel has a depth of 14 feet at high water, with a 4-knot tide, this was found to be impossible, and it was decided to erect a bridge. A temporary timber bridge (one third of a mile long and involving a diversion of nearly two miles) was completed in August, 1896, when platelaying was at once commenced and for nearly three years the whole of the traffic was carried over this structure until the opening of the fine Salisbury bridge, which now spans the waterway. This long steel bridge, erected on screw piles, was completed in June, 1899, and is the principal permanent structure on the first 360 miles of the rail-

THE OTHER HALF OF THE TSAVO BRIDGE.
Showing provision for flood stage of the stream.

way. Its spans are 60 feet, and on top of the girders is a roadway with a footway for men engaged on the railway.

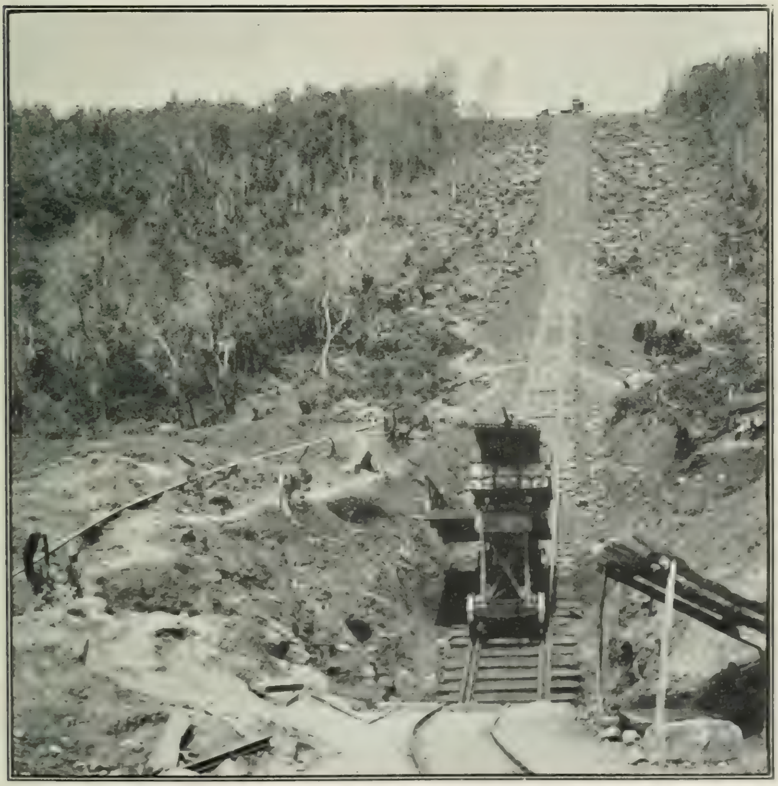
Immediately after leaving Kilindini the formidable ascent of the Rabai Hills is commenced, a work which involved some of the heaviest work on the line in embankments and cuttings, and during the construction of these heavy works it was necessary to put in a considerable length of temporary line with gradients of 1 to 30 and curves of 400-feet radius. At mile 50 the line enters the Taru Desert, and the section more nearly approaches a surface line: Here the difficulty was not in the construction of earthworks, but in the clearing of dense thorn jungle and the grubbing up of the stumps. The Taru Desert extends to Tsavo (mile 132), but beyond Voi station (mile 100) there is a ruling gradient of 1 in 66. The bridge of four spans of 60 feet over the Tsavo is the second largest bridge on the line. The other girder bridges of 40-feet span and upwards are of three types as regards piers and abutments; (1), masonry piers and abutments; (2), piers and abutments of concrete; (3), trestle piers composed of steel cylinders filled with concrete and braced together. The largest single-span girder bridge on the railway is 100-feet clear span. In the ascent and descent of the great Rift Valley some very heavy and difficult work has had to be carried out. For the descent from Kikuyu to the floor of the valley 13 miles of line is required and no less than eight ravines have had to be bridged on this section by steel-trestle viaducts varying from 120 feet to 780 feet in length and from 32 feet to 85 feet in height at the deepest points. These viaducts are erected very rapidly by means of a traveller with a long jib. Leaving the valley, the first 15 miles of the Mau Range (the highest section of the line) is easy, but this is followed by over 70 miles of country which will involve the most costly and difficult work of the whole line. In this section there will be no less than 28 steel viaducts varying from 160 to 880 feet in length and from 30 to 110 feet in height. 46 miles from the Lake terminus at Port Florence there will be a tunnel of 200 yards in length, the only tunnel on the whole railway. Between Kikuyu and the lake, some very heavy temporary works have been necessitated for the negotiation of the gradients during the construction of the permanent way round the escarpment. As the portion of the line descending into the Rift valley would have occupied more than a year in construction, a rope incline was built for the purpose of lowering materials into the valley. This lift or incline overcomes a difference of level of 1,523 feet and is in four sections. Two of these have gradients of 16 per cent. and 9½ per cent., are laid with double lines, and by means of carriers with horizontal tops attached to steel hawsers running over a drum, on which the waggons are placed,

PERMANENT LINE ON THE KIKUYU ESCARPMENT.

trucks are run up and down the inclines. The full waggons going down haul the empty ones up, the speed being regulated by brakes on the drums. The two middle portions of the incline have gradients of nearly 50 per cent.

Having dealt briefly with some of the difficulties encountered by the engineers in the construction of the Great African line, a few figures regarding the stations, rolling stock, etc., will not be inappropriate.

The whole of the line is single except at the stations and is of one-metre gauge, the rails being of the Vignoles section, 50 pounds to the yard. Wherever possible steel sleepers have been employed, but where the condition of the soil did not allow of this, creosoted wood has been used. Nairobi is the headquarters of the line and round it a considerable collection of galvanised houses has sprung up. This place (mile 326), 5,600 feet above sea level, is the last bit of level plain be-



TEMPORARY HAULAGE LINE OVER ESCARPMENT AT KIKUYU.

RAILWAY OFFICIALS AND THEIR TRAIN ON THE UGANDA RAILWAY.

fore entering the broken and difficult country adjacent to the Great Rift Valley. It will be the site of the central workshops and administrative offices. In addition to the two termini there will be engine-changing stations at Voi, Makindu, and Nakuro. The various stations are constructed of corrugated iron with wood linings. There are 92 locomotives on the line, of which 34 are English engines of the standard type and 35 standard-type engines supplied by the Baldwin company in America. These correspond to the Indian "F class" engines. The orders for these latter, together with the thirty-four bridges ordered from the American Bridge Company of a total value

VOI—A TYPICAL RAILWAY STATION ON THE UGANDA LINE.

of $1,000,000, were placed in America owing to the fact that English firms were unable to supply them within the required time,—an outcome of the great engineers' strike. The rolling stock consists of 149 passenger vehicles, made in England and of the Indian pattern, 3 horse boxes, 25 cattle trucks, 3 powder vans, 60 special water-tank waggons, 50 brake vans, and 850 goods waggons. In all cases the rolling stock is fitted with steel underframes and all are supplied with central buffers.

Dealing with the prospects of the road from an economic point of view, it is interesting to note that when the line was only open to mile 362, the earnings from public traffic amounted to £3 to £4 per mile per week. There should be a great improvement when the rails reach the lake, and when steamers have been launched upon it. At any rate, it is hoped that the traffic receipts will pay the cost of working. The railway has a practical value, however, far beyond the actual amount of revenue it may earn. The saving in transport by rail, as compared with porterage, is enormous to the great advantage of the Protectorates' revenues. In the time of the Uganda mutiny of 1898 the troops and stores were trained up the 140 miles of railway, which had been thus rapidly laid, and the situation was saved. Stores, troops, and other passengers connected with the Protectorate have been conveyed

A CUTTING NEAR THE HEAD OF THE RAILWAY.

to the extent of 5,000 tons of stores and 47,000 passengers, including troops. Up to June last the difference in cost of conveying these by rail as against road transport amounted to £300,000. A glance at any map of Africa is sufficient to shew the immense value of this important branch of the Great Cape-to-Cairo system. In connection with the line a service of steamers on the Victoria Lake is being organised for the carriage of local and imported goods over the waters of this inland sea. The boats, which are conveyed to rail head in sections, in which state they are shipped from England, will have a speed of 10 knots when loaded, will be fitted with twin screws and triple-expansion engines, and have a cargo capacity of 150 tons. It is scarcely necessary to point out how this line will completely revolutionise this part of Africa and the effect the iron horse will have on the many tribes living along the route. Sir Harry Johnstone, His Majesty's Special Commissioner, graphically refers to this when he says "The railway has taught the negro the value of honest work; it has saved thousands from death by famine. To the hungry people of East Africa, dying from the result of three years' drought, the railway has brought food and shelter; and no sign of the times was to me more encouraging than to see Masai—actual Masai—who a year ago would have scorned any other avocation than cattle tending, cattle raiding, and the slaughter of other negro tribes, working as navvies on the railway line, de-

GROUP OF FAMINE SUFFERERS ON THE LINE AT KIBWEZI.

PORT VICTORIA—THE TERMINUS OF THE LINE IN THE HEART OF AFRICA.
The natives are carrying sections of a light steamer for service on Lake Victoria.

cently clad for the first time in their lives. The Indian coolie travelling through this land, not of nudity so much as of flagrant indecency, has brought home to the native the fact that his nudity is repulsive. There is probably no more decent land than India, and no more prudish person than the native of India. It is not exaggeration to say that one of the first objects of the Indian coolie has been to put his fellow-workman into breeches. Along the railway line, clothing worn in this sense has become fashionable, and the result is an increased demand for khaki and calico in the Indian bazar or at the white man's store."

The accompanying time-table will prove not uninteresting in this connection. What a revelation to those who until quite recently were

THE TRACTION ENGINE WHICH GOES AHEAD OF THE RAIL LAYERS.

UP TRAINS.			DOWN TRAINS.		
Mombasa	dep.	11 40.	Escarpment	dep.	15 20.
Kilindini	arr.	11 48.	Nairobi	arr.	17 50.
	dep.	12 0.		dep.	10 0.
Voi	arr.	18 40.	Makindu	arr.	18 15.
	dep.	19 40.		dep.	19 0.
Makindu	arr.	4 3.	Voi	arr.	2 0.
	dep.	5 50.		dep.	2 30.
Nairobi	arr.	15 30.	Kilindini	arr.	9 30.
	dep.	9 0.		dep.	9 40.
Escarpment	arr.	13 30.	Mombasa	arr.	9 50.

A word about the goods traffic. At present it is practically all up-country, less than 5 per cent. of the 9,235 tons carried during 1899 being seawards. When the lake is reached there is every reason to expect large consignments of ivory, hides, and horns. Already the railway is beginning to divert traffic from the adjacent German territory, and ever since it was opened beyond Voi, the German stations have been drawing their supplies from the British route while goods hitherto conveyed on men's heads to the German posts on Lake Victoria are now being conveyed via railroad to the lake.

Sir Guilford Molesworth has expressed the following opinion concerning the effect of the railway in the development of this great country: "In East Africa the railway takes the place of roads, which are practically valueless owing to the absence of water and the mortality in transport animals.

"It must be borne in mind that the construction of a railway in a new country often develops traffic from entirely unexpected sources, more especially by checking lawlessness, which might previously put a stop to small trading.

"Broken up as East Africa is into various petty tribes, perpetually at war with one another, it has been hitherto impossible to carry on any trade, except by means of large and well-armed caravans, and even then at great risk. Some tribes have subsisted to a great extent on plunder from their weaker neighbours, so that there has been no stimulus to the more peaceable to produce anything beyond the small requirements of their own tribe.

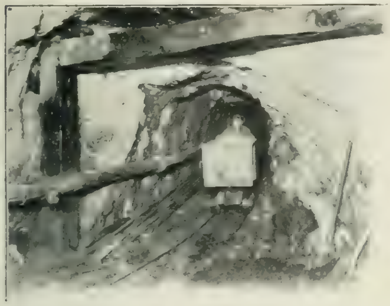
"With the completion of the railway, the whole lake coastline of 800 to 1,000 miles, with the adjoining fertile and populous districts, will be opened up by water communication to railway traffic. And as the Uganda Railway will be the first to tap the lake, the trade of these districts will naturally gravitate into this channel, which will become the established trade route."

The profile and photographs accompanying this article were courteously lent by the Railway Committee.

THE MANAGEMENT AND CONTROL OF THE COLLIERY.

By William Blakemore.

The mine is usually, of necessity, a self-contained community. Its isolation, like that of the ship at sea, compels it to rely upon its own assembled resources and very largely upon its own internal government. It therefore affords a concentrated study of power generation, transmission, and utilization, of mechanical applications and transport, of stores keeping, accounting, and, above all, of labor management. Mr. Blakemore traces the lines of a system broad enough to include and bring into proper relation all of these many functions. The present paper considers underground workings. A following one will discuss surface arrangements. THE EDITORS.



SINCE the tendency to specialize has been developed to such an extent, the duties of a mine manager have undergone considerable modification, chiefly in the direction of relieving him from details, which formerly made great demands on his time, but which under competent supervision can be as well, or better, performed by men whose training has qualified them to be experts in their own department. This does not relieve a manager from the necessity to fit himself by thorough training and education to be an "all-round man," but it has resulted in enabling him to exercise more efficient control by concentrating his attention upon the more important matters and discharging other functions by the aid of competent assistants. A right understanding and a judicious application of this principle is today the secret of successful management.

In the selection of no career is it more necessary for a young man to consider carefully in advance what are the requirements, than in that of a colliery manager, because there is probably no calling for which a greater diversity of gifts is requisite. Briefly, he requires a robust constitution; a thorough scientific training embracing at least geology, chemistry, pure and applied mathematics; and a practical training of the most thorough character in which he will have an opportunity of seeing how a knowledge of these sciences is applied to the successful management of mining operations. In addition he must be able to adapt himself readily to varying and extreme conditions of circumstance and environment, and possess both courage and promptitude in dealing with emergencies which may be of a catastrophic character. It is not less necessary that he should be a good judge of human nature to enable him to handle without undue friction, and at the same time with firmness, the workmen whom he will have to control. The absence of any one of these leading qualifications will determine the permanent consignment of a colliery manager to departmental work; the possession of all of them will, with the ordinary qualities of perseverance and character, enable him to rise to the top of the profession and ensure him a position of influence and affluence.

Thus equipped, we will assume that the colliery manager is sent into a new country to search for coal. He will confine his attention to the Carboniferous series if they exist in that section; if not, he must expect to find his coal in the Cretaceous formation. In the former case it is more likely to lie either horizontally or at an easy angle, because less liable to violent upheavals and dislocations. In the latter he may not improbably find his coal in a mountainous district, with outcrops either along the mountain sides at a considerable elevation, or in the creeks where the surface has been eroded and the coal exposed.

In the absence of outcrops he will have to resort to boring; and while for shallow depths of a few hundred feet in favorable ground, that is, ground that is neither too hard nor too soft, boring rods may be used, they have for all serious operations been entirely superseded by the diamond drill, the especial advantage of which is greater rapidity of operation and the securing of a "core" which furnishes more information than can be obtained from "punchings." Even where coal has been discovered it is often necessary to resort to boring, in order to determine its extent, the depth of the seam on different parts of the property, whether there are any large faults intersecting it, and whether the quality and thickness continue uniformly over a sufficient area to justify development. Where the range of outcrops is limited it always pays to determine these facts by boring before proceeding with the erection of plant and the expenditure of capital. It may be mentioned that the cost of boring by means of the diamond drill is much dearer than with rods for moderate depths, but after one thousand feet have been passed the advantage is in favor of the drill. A fair estimate of the average cost of boring with rods to the depth of a thousand feet would be $1,500 and the rate of progress from one to fifteen feet a day. With a diamond drill the cost would be $5,000, but the work would be done in a quarter of the time.

Having thus prospected the property, the location of the mine is the next matter to be settled, and this will be determined mainly by the following considerations: the area to be worked, the output required to yield a profit on the expenditure, the quantity of water to be dealt with, the number of shafts to be sunk, the best position in which to locate the shafts having regard to the conditions of the seams and easiest access to the market. To overlook any of these considerations may handicap a mine permanently. Wherever practicable, it is economical to open a mine by means of an adit from the surface instead of by shafts, thus saving the cost of a hoisting plant, and in cases where the seam is thick enough or the roof favorable for "ripping," to run the main-line locomotive direct into the mine. In case of shaft winnings the quantity of water becomes the most important factor. Formerly it was the practice to locate the shafts in the "deep" in order to have "crop" haulage and natural gravitation for the water, the whole of which was pumped from the deepest part of the property direct to the surface. If however, the quantity be large, modern practice favors locating the shafts nearer the centre of the property and pumping the water from the deep workings by underground pumps.

Where sinking is necessary there are two questions to solve—the form of shaft and the method of sinking to be adopted. The former may either be round, elliptical, or rectangular; this will be determined entirely by the nature of the strata and the necessity or otherwise for walling the shaft. Where the measures passed through are soft and yielding, a round shaft, well-walled, may be necessary; where they are strong and consist largely of rock, a rectangular shaft is much better and cheaper. In very strong measures its size need be limited only by the convenience of the mine, the narrow measurement always corresponding to the length of the cage and the long measurement to the number of compartments required. The method adopted will be governed by two considerations—the character of the strata and the quantity of water; where the latter is exceedingly great and other conditions not unfavorable, the Kind-Chaudron process has been very successful, although costly. One of its strong features is that it allows the tubbing ultimately to be seated securely below the water-bearing strata, and does away with the expensive process of coffering. In Germany and Belgium several successes have been scored by the Poetsch freezing process, but it has not been adopted to any considerable extent. In the ordinary method of sinking, which is of course the most economical when conditions are favorable, it may be found necessary to resort to piling when passing through loose ground, or even to use boxing or tubbing, and in cases where the water-bearing strata extend for any considerable depth, the shaft will have to be lined with iron tubbing. The average cost of coffering in a round shaft 20 feet diameter may be put at $40 per foot, and for iron tubbing or lining from $100 to $300. The probable cost of sinking such a shaft without pumps would be $30 a foot, with pumps $45, and in hard rock $80. For comparison a rectangular shaft 24 feet by 7 feet with favorable strata has been sunk for $15 per foot where no pumping was required, and for $30 with timbering.

It is important in connection with sinking to bear in mind the necessity for some special provision for ventilation, a matter which has often been overlooked or very inadequately attended to. In large rectangular shafts this can be effected with brattice for moderate depths, but the safest plan is to use a temporary fan and put in ventilating pipes, one of which should be carried underneath the scaffold, whenever the latter is suspended in the shaft, to prevent accumulations of gas.

When the coal is won the "lay out" and the system of mining to be adopted receive the next consideration. The best practice in large mines looking to an output of 2,000 to 3,000 tons a day is the three-entry system, which furnishes better facilities both for haulage and ventilation than any other, and is equally applicable to shaft or adit entry. Mine haulage levels should be driven wherever practicable with a slight rise, not exceeding 0.80 per cent. in favor of the load. The limit to which they can be carried depends upon the nature of the coal, roof, and floor, and the extent of the area to be recovered. Where these are favorable it is probable that no actual limit has yet been reached, although in one case the workings have been carried five miles from the shaft. It may however be taken for granted that under favorable conditions one entry can recover at least ten square miles. The system of working may be either "long-wall" or "pillar-and-stall." In every case the lay out will proceed upon the same principle of utilizing gravitation to the utmost possible extent, and it may here be pointed out that this law lies at the basis of all mining operations, and that there is not one process from the time the coal is cut until it is dispatched to the market which should not be conducted by its aid. The grade of all roads should favor the haulage. The arrangement of handling appliances should leave as little to be done by machinery as possible and as much by natural fall, so that in a well-organized mine the coal will not have to be handled from the moment it is loaded into cars at the face until it is dispatched in railway wagons or dumped into a coking furnace. If the main haulage is upon levels, the workings will naturally be to the rise, and secondary haulage should be employed to convey the coal from the face or rooms to the levels. If the rise is over 7 degrees this may be done by self-acting jigs, if over 20 degrees by chutes; if less than 7 degrees, rope or electric-locomotive haulage should be extended from the levels. Where the main recovery is a deep one a haulage road should be driven on the full "dip" of the coal, in which case it practically takes the place of a shaft. At a suitable distance the main haulage levels will then be driven at right angles, or nearly so, and the workings carried to the crop as in the first illustration. The system of working to be adopted will depend upon the following considerations: that long-wall requires a good roof and floor, a moderate grade, fairly strong coal, little water, and that the seam should not exceed under any circumstances 6 or 7 feet in thickness. The advantages of this system are that practically the whole of the coal can be recovered, that less pick work is required, especially in shearing, that the superincumbent pressure assists the operation of freeing the coal at the face, that fewer roads are required, that under favorable conditions it is cheaper, and that it makes room for a greater number of men in a given area, and consequently for a larger tonnage. The disadvantages are that the mine suffers much more than a pillar and-stall mine when laid idle, that it is more difficult to ventilate because of the crushing and closing of air ways, that it requires more timber, that the roads are much more expensive to maintain, and that the workings are more seriously affected by faults.

Where the coal is over 7 feet thick, and in nearly all cases of mining under mountains, it has been found cheaper and safer to adopt the pillar-and-stall system, and in fact it is often not practicable to adopt any other. The chief objection to this system in the past has been the larger amount of pick work required, and a corresponding increase in the cost of production; but since this has been overcome by the introduction of coal-cutting machinery the objection is of less importance. Broadly speaking, however, the system to be adopted must in almost every case depend upon the physical conditions which pertain to the mine. This leads to a consideration of coal production at the face, on which matter it may be stated that all new mines should from the commencement be equipped for the use of coal-cutting machinery. The battle over this has waged long and fiercely, but it has been won, and no colliery manager can in the future afford to resort to hand-pick work where it is possible to use a machine.

In long-wall working the use of what is called the long-wall machine has been attended with surprising results, as much as 500 tons a day being produced by one machine, at a cost of two cents a ton for under-cutting, under my own supervision. Such a result can only be achieved under very favorable conditions, involving a fairly high seam, strong roof, good pavement, and plenty of clearance at the face. The difficulty hitherto in long-wall workings has been to provide these conditions, and in thin seams it may not be possible. As between the chain machine and the cutter bar, the former is undoubtedly capable of a larger production. In pillar-and-room workings there is a choice of machines; either the percussion or rotary may be used. So far the percussion has been most favored, because it is so much lighter; but upon easy grades the small chain machine, weighing from 2,000 to 3,000 pounds, has demonstrated itself to be a most efficient instrument as compared with the percussion machine. It is safe to say that the latter in good hands will cut an average of three 20-feet rooms for a day's work, whilst the chain machine will cut six to eight. The selection of these machines will be governed also by a consideration of the grade upon which they have to work. The difference in cost between hand mining and machine mining varies from 12 cents to 20 cents a ton, according to circumstances, in favor of the latter.

The question of haulage is the next important consideration, and there is a wide range of systems claiming attention. The manager may use endless-rope or chain haulage, main and tail rope, electric or compressed-air locomotive; but he may rely upon it that if he has thoroughly mastered the conditions of his mine, only one of these is worthy of adoption. For any particular installation on grades not exceeding 2 per cent. the electric locomotive is the most efficient and economical method of hauling in use. At any greater angle of inclination the endless haulage rope naturally takes its place, in fact there are circumstances under which this claims first attention, mainly where an exceedingly large tonnage is required to be moved. Endless haulage has been worked advantageously upon all grades up to 40 per cent., but it is doubtful whether on very steep grades it would not be cheaper to duplicate the entry, and haul direct. On main deeps of a moderate inclination the endless rope is far ahead of any other system, its capacity being practically unlimited, and for the expenditure required no other system gives as good a result. A mine equipped with endless haulage on its main deep or level and either self-acting jigs or chutes from the workings to the main or secondary haulage, has solved the transportation problem below ground and made it almost possible to do without horses or mules.

The transmission of power for all purposes below ground is an important matter and one which at the moment is showing the most interesting development. The manager has a choice of wire ropes, steam, compressed air, and electricity as a motive power. All have their votaries and under special conditions each one possesses some advantage. To generalize, it may be said that wire-rope transmission is cheaper than any other up to one mile; after that electricity takes the lead. Within that radius compressed air is capable of doing very good work, being safe, easy to apply, and helpful to the ventilation. On the other hand, it is at least 20 to 25 per cent. dearer to instal than electricity, the greatest feature of the latter being the facility with which it can be adapted to various uses, its high efficiency, and its greater safety in the absence of gas. Bulkiness of pipe connections is a constant source of danger and inconvenience which does not exist in the case of cables. On the other hand, the use of electricity is limited, and in fact determined, by the element of danger which pertains to it; and to overcome this is the task of the electrical engineer of the future. It is being used where there is no gas, but there is a growing indisposition to take the cables into the working face whenever gas has been seen. At present its greatest use is for hauling and pumping, as these operations can be carried on as a rule sufficiently far from the working faces, where the greatest danger exists.

On the score of safety the most important branch of a colliery manager's duties relates to the system of ventilation adopted, and its maintenance in first-class order. Ventilating furnaces may be regarded as a thing of the past, and the manager can confine his attention entirely to the subject of fan ventilation. Here, again, there is a wide choice ranging between high-speed and low-speed fans. The considerations which should guide him in the selection are the following: the size of air ways that can be maintained, the quantity of air required to be circulated, and the probable water gauge. In considering these points it is well to look to the future, and to bear in mind the possibilities of a greater development than may appear probable at present. At the same time, it is a mistake to put in a plant of very much greater capacity than is needed, because the efficiency is lowered if the speed is brought below a certain point, and there are instances in which it would be cheaper to instal a small plant in the first instance and to replace it with a larger one subsequently. It may be taken for granted that the best results are being obtained today from comparatively high-speed fans, that is, fans with periphery speed of 100 to 200 feet a second; and of these there are several makes of so nearly equal merit that it would be invidious to particularize, beyond saying that the best known are the Walker, the Chandler, the Capell, and the Schiele. The feature of ventilation during late years has been the development of "splitting" the air current, a principle the judicious application of which is today the best test for an expert in ventilation.

The elucidation of the coal-dust theory and the study of explosives have contributed much to the importance of ventilation, which now has to be considered in connection with both. With reference to coal dust it may be positively ascertained that the presence of 1 to 2 per cent. of gas in a dry and dusty mine creates the possibility of an explosion, and is in every instance an imminent source of danger. When it is remembered that under normal conditions and in the absence of coal dust 5 to 7 per cent. is the dangerous mixture, it will be seen how greatly the situation is altered by the presence of coal dust. No perfectly satisfactory method of dealing with this agent has yet been discovered. Attempts are made to remove it, but this can only be done very partially. It may, and indeed must, be collected from the floor, and this becomes an urgent duty now that the danger of its presence is known; but it cannot be swept from the working places where it is generated every day, and where as a rule the gas also is to be found. Attempts to damp the coal dust have been attended with some degree of success, especially when salt is used in the water, and some of the deeper mines have installed a regular system of pipe lines, by means of which they can sprinkle almost every part of the mine. This is done most effectively in combination with compressed air which is introduced into the water pipes near the nozzle and forms an excellent spray.

The subject of blasting is of even greater importance and has led to endless controversy of late years. The danger of blown-out shots, and the lesser danger of firing gas in a crevice at the back of a shot hole when the blast is discharged, are the two features which have received most attention. In connection with this matter the manager who understands his business will be extremely cautious in the use of explosives of any kind, in a gaseous mine, and will keep a keen lookout for the development of mechanical appliances, which are probably destined to supersede blasting in coal mines at no very distant date. While some high-class explosives are safer than powder, they are only relatively, and not actually, safe, and none of them is so well adapted for the purpose from an economical standpoint. The average cost of blasting with high explosives as compared with ordinary powder is probably 50 per cent. higher, and the breakage of coal is much greater.

THE MANUFACTURE OF IRON AND STEEL IN CAPE BRETON

By P. T. McGrath.

England won and long held supremacy in steel-making, in spite of relatively inferior iron-ore resources, because of unsurpassed fuel supplies and a sound and magnificent commercial system. The younger industry in the United States, with the handicap of a later start and widely divided material resources, won the ascendancy by concentrated study of intensified production, mechanical applications, and labour-saving methods. Cheap transport almost neutralised the wide distances between ores, fuel, and furnaces. Now, when international interest is concentrated on the rivalry, a new competitor appears on the Canadian seaboard, with claims to greater natural advantages than either England or the United States can show, and a clear foundation upon which to build according to the most advanced and successful practice. If the comprehensive grasp of all the elements of steel manufacture can be obtained in this region naturally, the artificial combination of the Steel Trust can hardly monopolise the trade of the world. It is in this light that the situation at Cape Breton has an interest warranting attention.—THE EDITORS.

AN enterprise for which its promoters claim that it will enable them to dictate the price of iron and steel for all the world is now taking shape at Sydney, Cape Breton. It comprehends the establishment of a great smelting works, complete in every detail and of the most modern design; and provision has been made for its eventual rounding off by the addition of a plant for the building and engining of steel ships and the docking and repair of damaged ocean steamers.

The initiation of this enterprise must be a matter of no small moment to British and American ironmasters, for the many advantages it enjoys are certain to react upon the like industries in both these countries. As a competitor with them it must in a few years attain a prominent place, and so clear is its superiority in many instances that a second plant is being arranged for at North Sydney, a few miles away, and a third may be set up in the near future at the Gut of Canso, in the same region and where the conditions are almost similar.

The factors which have contributed to the project taking shape are: The existence of vast beds of coal and limestone in Cape Breton, the recent discovery of immense iron deposits in Newfoundland near by, the comparative nearness of Sydney to the markets of Europe, and the stimulus which Canada gives to iron production by a bounty granted on all iron and steel manufactured within the Dominion. The fact that Sydney lies right on the seaboard and that thereby extra handlings are avoided also formed a reason, and the steady advance in the prices of iron and steel during the past two years, with the apparent certainty of high rates being maintained, supplied the last argument required to transmute theory into action.

The inspiration for the venture came from Mr. Henry M. Whitney, a progressive American capitalist and a brother of the Hon. W. C. Whitney, who was Secretary of the Navy under President Cleveland.

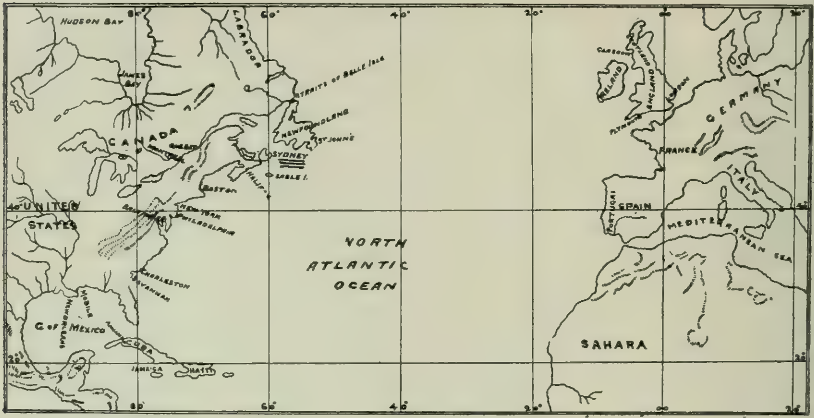
When the recent boom in iron marked the world's industrial onrush, Mr. Whitney promptly grasped the significance of its bearing upon Sydney as the location of a great steel-making plant, and he soon enlisted the active co-operation of such prominent Canadian capitalists as Sir William Van Horne, president of the Canadian Pacific Railway; Mr. R. B. Angus, the retired manager of the Bank of Montreal, and Mr. R. G. Reid, the Newfoundland railway king. With these and others he formed the Dominion Iron and Steel Company, capitalizing at $20,000,000, with a charter from the Government of Canada and Mr. Whitney as presiding and directing genius.

Sydney was selected as the site for the steel works because it was already the outlet for the coal trade, it was located in the centre of the coal and limestone region, and it possessed a tract of land near the water front eminently suited for the purpose in view. Sydney harbour is large, safe, and capacious. It has already become known to shipmasters as a coaling port and it is the half-way house to the Gulf of St. Lawrence. It is five miles long and the average depth of water is 50 feet. The entrance is wide and unobstructed, and the harbour is sheltered by the neighbouring uplands so that a fleet might swing at anchor there. Last summer seven British and three French war-ships lay there together, besides other shipping. It is the terminus of the Intercolonial Railway of Canada, by means of which connection is made with every part of the western continent; a railway 40 miles long and operated by the coal company connects with Louisburg, another shipping port; and it is a point of call for American and Canadian coast steamer lines.

These advantages, however, are trivial when compared with the superiority which its geographical position affords. It lies at the most easterly point of Cape Breton, and, excepting Newfoundland, is nearer to Europe than any other part of North America. From Sydney to Liverpool is but 2,282 miles, while from New York it is 3,110 miles and from Philadelphia 3,160 miles (these being the ports whence the Pittsburg and Chicago produce is shipped) to the Mersey. The com-

A GENERAL VIEW OF THE SYDNEY BLAST-FURNACE PLANT.

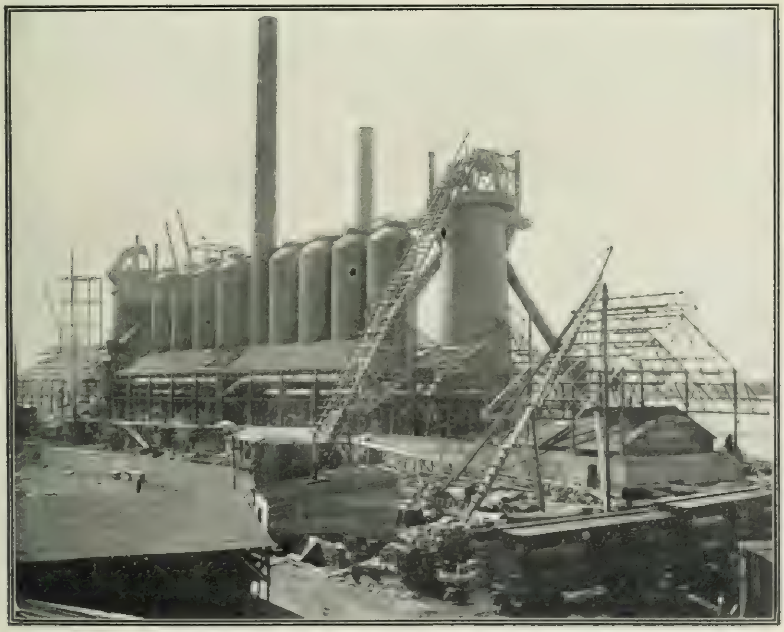
parison is even more detrimental to Mobile (4,506 miles) and New Orleans (4,553 miles) these being the outlets for the Alabama smelters. Sydney, therefore, enjoys the initial advantage of being almost 1,000 miles nearer the English market than New York and 2,200 miles nearer than New Orleans.



MAP SHOWING THE ADVANTAGEOUS GEOGRAPHICAL POSITION OF SYDNEY.

With regard to coal, the situation is as favourable. The coal areas held by the Dominion Company cover 200 square miles of productive measures, with several workable seams each several feet in thickness. The potential output is therefore almost appalling in its immensity. One of the directors has put it graphically by this formula: "We can produce 3,000,000 tons per annum for 1,000 years." Though the present output is equal to all existing demands, the inauguration of the steel works and the prospect of subsidiary industries necessitated provision for a largely increased production. A new shaft was accordingly sunk last year. Its capacity is 4,000 tons a day and there are 58,000,000 tons in sight, a supply for over fifty years. This is the greatest mining shaft on the western continent, by 1,000 tons a day. Nearly 1,100 men can work in it at once, its pit is 55 feet square, and it is to be the mainstay of the smelters. The shipping pier at Sydney has a daily capacity of 15,000 tons, and five steamers can load there at the same time, while the Louisburg pier can deal with 8,000 tons daily and three steamers at once. The line of railway between the two ports is operated by 120-ton locomotives, which have hauled 100 cars of 15 tons of coal each, though the average load is 900 tons.

The Sydney coal is bituminous. A series of experiments showed it to be admirably adapted for the purposes of smelting, and the practical tests confirmed this conclusion. It was found that it was only slightly higher in sulphur than the Connellsville coal, and that the excess could be economically washed out. But the plant started with the unwashed product, having the advantage of an unusually pure flux, which contributed not a little in controlling the sulphur. The second cast from the furnace assured this control and the fifth reduced it down to 0.019 per cent., which for most purposes is too low, rather than too high. The unwashed Sydney coal gives a coke with but 6½ to 7½ per cent. of ash as against 10½ to 11 per cent. in the Connellsville; while in fixed carbon Sydney gives 90½ to 91 per cent. as against 89½ in its competitor. In the letter of general manager Moxham to president Whitney, dated March 1st, 1901, which was published in connection with the recent flotation of Dominion Iron and Steel Company preferred stock, he says, in reference to the coal:



FURNACES AT SYDNEY DURING CONSTRUCTION.

"We are operating our bye-product ovens with unwashed coal, nevertheless the coke manufactured is of excellent physical quality. It is capable of hard driving and of maintaining the burden in the blast furnace without trouble. While slightly higher in sulphur—as must be the case until we wash it—our pure flux renders this no disadvantage to us. We have demonstrated that the question of washing is not a necessity, but purely an economic question. The coke from washed coal will be fully equal to the celebrated Connellsville standard—the sulphur will be no higher, the ash lower and carbon higher."

All the coal and limestone required for the furtherance of the project are obtainable within a very short distance from Sydney and can be mined at a figure so low as to be thought incredible in other quarters, but the economic phases of the venture had been carefully studied and the cheapening in the cost of the marketable product as a result of this fortunate natural combination was not overlooked.

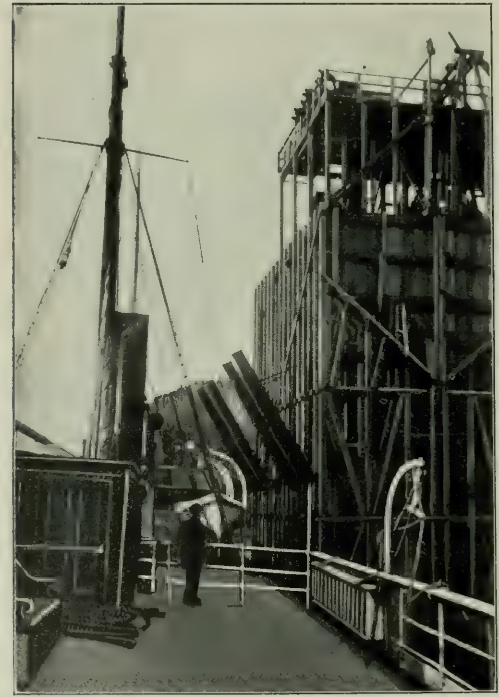
The acquisition, however, by the steel company, of the hematite iron deposit at Bell Island, Newfoundland, was the circumstance which above all others made the enterprise possible. This is the most remarkable mine of its kind in the world—an open quarry, as it were, of ore, accessible by merely stripping off a surface covering of rock and loosening the hematite strata by steam drills and dynamite charges. Bell Island lies in Conception Bay, about 35 miles by water from St. Johns, and 380 from Sydney. It is 8 miles long by 3 broad, and the hematite beds, five in number but only two commercially valuable, lie upon its northern shore. An expert authority states that the upper workable bed has an area of 240 acres and a thickness of 6 feet, which should yield 6,000,000 tons, at 6 cubic feet to the ton. The lower bed is

WORKINGS AT THE BELL ISLAND IRON MINES.

THE IRON MINE AT BELL ISLAND.

much larger—817 acres, and 8 feet thick, giving about 28,000,000 tons in sight. This bed, which dips downward at an angle of 8 degrees, extends out under the waters of the bay, and there is good ground for believing that when the ore now available is exhausted submarine workings may provide an additional supply the extent of which cannot be estimated. This deposit was discovered by some fishermen a few years ago, who brought some blocks of it to St. Johns as ballast for their boat, with only the vaguest ideas of its value. Its worth was realised there by some speculators to whom it was shown, and mining rights over the property were secured by them and the original finders. The Nova Scotia Steel Company purchased the property from these holders in 1897 for $120,000 and developed it considerably, uncovering and mining much of the ore, building a shipping pier at a suitable point on the east face of the island, and laying a tramway to connect the mine and the pier, by means of which they were enabled, during 1897, 1898, and 1899, to ship over 500,000 tons of ore, to their own works at Ferrona (Nova Scotia), Baltimore, Philadelphia, and Rotterdam, where they readily found a market for it.

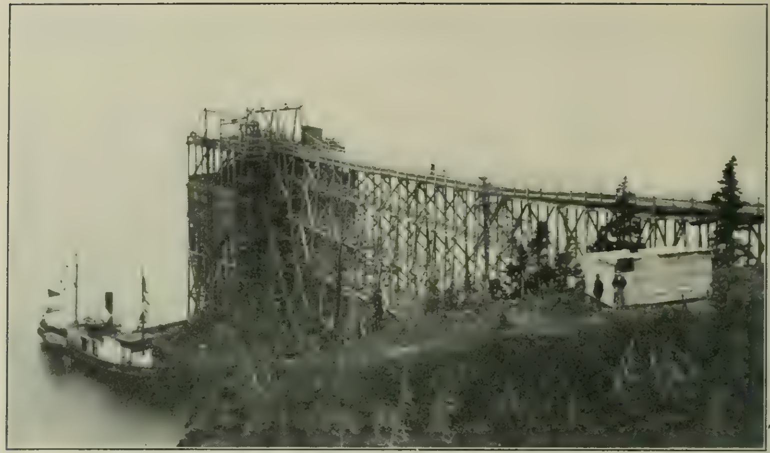
Last summer the Dominion company purchased from the Nova Scotia corporation the larger bed, paying $1,000,000 for it, with the tramway, pier, and other appurtenances, the vendors retaining the upper bed for their own use. The ore in both is almost identical, containing about 55 per cent. of metallic iron; and along an outcrop of 3½ miles no dislocation of the strata has been found, the ore being exposed over most of its extent, thus giving unusual facilities for open-cut working, so that probably 4,000,000 tons can be got out by this means. No elaborate machinery is therefore necessary. The tramway is carried along to the face of the working, and shifted as this recedes. The cars run by gravity, a double-track line, two miles long, conveying them to the pier, the loaded cars going out on one set of rails and the empties returning on the other. The ore is in small rectangular cubes, a few inches each way, and millions of these are set together to form the deposit, in regular layers, one upon another, like a huge structure of small bricks. The upper surface of the strata seems an immense tiled floor. The deposit is veined through and through with these lines of cleavage, and, while the mass cannot be sundered except by charges of dynamite, the resultant explosion shatters a portion of the deposit into its millions of perfect rhomboidal fragments, which are shovelled by the workmen into the waiting ore cars, much as anthracite coal is handled. The cars grip onto an endless cable and at the pier are automatically upset, the contents falling into one of the ten pockets into which it is divided. Each pocket holds 200 tons, and the contents are discharged by gravity into a steamer's hold, ten minutes sufficing to empty a pocket. Behind the pier a reservoir has been excavated in the hillside, with a capacity of 20,000 tons, and from it an endless chain of small hoppers carries this ore along to the pier, the ship's loading being completed by the discharging of their contents into her hold after the pockets have been emptied. A 5,000-ton boat can be loaded in from 4



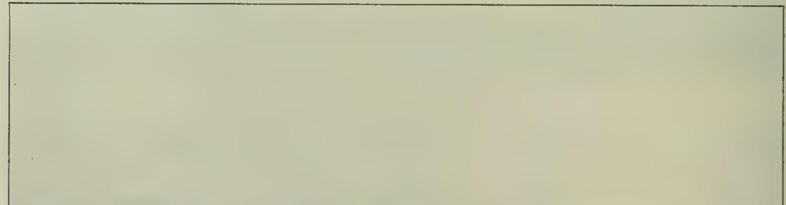
VESSEL LOADING AT THE ORE PIER AT BELL ISLAND, NEWFOUNDLAND.

LOOP AND AUTOMATIC DISCHARGE FOR TRAM CARS ABOVE THE ORE PIER.

THE BELL ISLAND PIER. LOOKING DOWN THE TRAMWAY.



THE ORE PIER AND TRESTLE APPROACH.



CABLE TRAMWAY FROM MINE TO PIER. FULL CARS DESCENDING AND EMPTIES COMING UP.

to 5 hours. The tramway has a capacity of hauling 3,000 tons to the pier in 10 hours, but this can be doubled by increasing the rolling stock. The depth of water at the pier is 24 feet, and a second one is now being built, which will enable the output to be duplicated, as the bay is closed by ice during four months of the year and a full supply must be obtained in the other eight months.

It has already been shown that coal and limestone are most favourably located as regards Sydney, being at its very back door, so to speak. The possession of the Bell Island mine enables the Dominion company to procure iron ore at a lower price, to manufacture it cheaper, and to sell the product for less, than anywhere else in the world and yet make as large profits as any competitor. The cost of mining this ore and loading it on shipboard has been proven by the Nova Scotia company, by three years' experience, to be 45 cents a ton. The freight to Sydney is another 45 cents. The unloading of it there costs about 10 cents. Allowing for increases in wages, for which the workmen are now agitating, and for other expenses, the ore can be fed to the blast furnaces in Sydney for not exceeding $1.25 a ton. The combination of advantages is unique. The ocean passage from Bell Island to Sydney occupies only 36 hours, and there is deep water the whole way, the largest ocean-going steamers being available for freighting the ore. There is but one handling, and no royalty is exacted.

Almost all the ore used in the United States comes from the great iron ranges of Minnesota, at the head of Lake Superior. This ore has to be brought by rail from the mines to the lakeside, then shipped on a whaleback and floated down through the canals to a port within easy access of the smelters, and there unloaded and railed again to the furnace mouth. Taking into account the several different portions of the country which absorb this ore it is correct to say that every ton of ore from Minnesota has to be handled three times, by rail, steamer, and rail again, and carried 800 miles from the pit to the smelter. It costs at least 50 to 80 cents a ton to mine it, nearly $1 to freight it by water, and 50 cents at least for the railroad carriage. Last year non-bessemer ores cost $2.50 a ton laid down in Pittsburg, and bessemer ores $3.25. The advantages in favour of Bell Island ore are thus very marked.

With coal the conditions are somewhat similar. Except the Pennsylvania furnaces, which have coal near at hand (but have to haul their iron ore extreme distances) all the other American smelters—save in Alabama—have to procure their coke supplies from centres 300 to 400 miles away, the railway carriage on this forming an important factor in the cost of the manufactured product. The American furnaces are also handicapped by their remoteness from the seaboard. The Pittsburg output has to be hauled by rail to tidewater at New York or Boston, an average distance of 450 miles, at a cost of ½ cent a mile per ton, or $2.25. The Alabama iron, to reach the littoral at New Orleans, must be carried some 530 miles, at a cost of $2.65, the ocean voyage then being 4,500 miles.

Sydney, on the other hand, lies right on the seaboard, the several processes involved in the mining and manufacture of the iron are carried on more cheaply and conveniently than elsewhere, the product is transferred from the smelter beyond the wharfside to the ocean steamer lying at the pier-head without any intermediate carriage by rail or river, and the distance to Europe is 800 miles less than from New York and 2,200 less than from New Orleans.

It is true that the Bell Island ore is not as rich as that of the Lake Superior region; but it is a high-grade ore, it mixes readily with others, its ease of mining and transport and its abundance and accessibility do much to equalise its shortage in mineral, and it is far richer than some ores which have set the standard of production in the past. The leading ores may be thus compared:

Lake Superior ore	63 per cent.
Bell Island ore	55 per cent.
Cleveland (Eng.) ore	42 per cent.
Alabama ore	40 per cent.

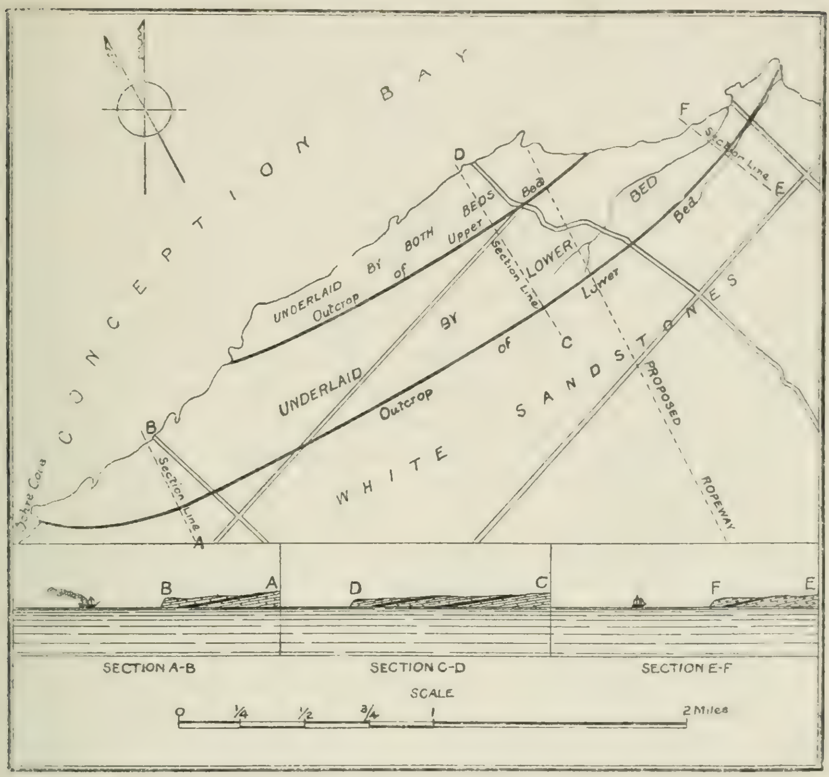
The cost of production also tells greatly in favour of Bell Island ore, and must make the Sydney output much sought after. The Nova Scotia Steel Company has been smelting it for three years and figures the cost as follows, the estimate for the iron being calculated on the basis of underground mining.

1.8 tons of ore	cost	$1.80
1.25 tons of coke	cost	1.80
.75 ton of limestone	cost	.40
Labour and incidentals		1.50
		$5.50

To convert this pig iron into steel billets involves an expenditure of $5 a ton more. And yet, last year the following prices ruled.

At Alabama, gray forge pig iron	$12.00
At Pittsburg, gray forge pig iron	19.00
At Pittsburg, Bessemer pig iron	22.00
At Pittsburg, Bessemer steel billets	37.00
At Pittsburg, open-hearth steel billets	42.00
At Glasgow, summerlie pig	21.00
At Glasgow, steel billets (warrants)	30.00

These prices, of course, were obtainable only during periods when a "boom" in iron prevailed, and could not be maintained if a reaction



MAP OF GREAT BELL ISLAND ORE DEPOSIT AND SECTIONS.

came. But at the prices just quoted for the cost of production at Sydney, plus $2.50 a ton freight to Europe, iron and steel from Sydney can be laid down in England at a handsome profit even in periods of depression. To land this pig iron in Liverpool would involve a total cost of $8.00 a ton and steel billets $13.00 a ton, and the average price at which these have sold in England the past ten years has been $14.60 for pig iron and $22.90 for steel billets.

The Sydney enterprise will also have the stimulus of the Canadian bounty to promote its development during its infant years. The enormous growth of the American iron output has been a source of bitter irritation to the Canadians for years past, the United States producing 160 times as much pig iron although having but 12 times the population. In the endeavour to remedy this condition of affairs the Dominion Government a few years ago provided a bounty to encourage the home production of iron and steel. But even after this the industry languished, and in 1898 only 77,000 tons of pig-iron were manufactured in Canada, and of the ore used 58 per cent. came from the United States and earned a lesser bounty of $2 a ton, Canadian ore being granted $3. The bounties were to expire in 1902, and there was little prospect of their renewal, until the Whitney capitalists entered the field with their plans for a large up-to-date plant, to be located at Sydney and fed with Newfoundland ore.

This entailed a reconsideration of the bonus policy by the Canadian Government, for while naturally objecting to subsidise American ore there were many cogent reasons for stimulating the development of the sister colony of Newfoundland. It was accordingly decided to extend the bounties for another five years, gradually reducing them by a sliding scale until they were extinguished in 1907. The Dominion Company will earn quite a sum by these bounties during the period they are in operation. The yearly capacity of the blast furnaces will be 511,000 tons (1,400 tons a day) which, at $2 a ton, will yield $1,022,000. The steel mill is to produce 800 tons daily, or 292,000 tons per annum, which, at another $1.50 a ton, will amount to $438,000, a yearly total in bounties of $1,460,000, which will likely yield nearly $6,000,000 in all, during the seven years ere the bounties cease.

From a consideration of all these circumstances it will, therefore, be readily realised that there is much point in the declaration of a leading American expert in iron and steel production, to the effect that the Sydney works will be able to dispose of its output at a figure at least $3 a ton less than Pittsburg can, and that this will represent a loss of $7,500,000 a year to the Pittsburg manufacturers on the present output of that place, as they will have to reduce their prices to meet those of their new competitors. The organisation of the Sydney enterprise is in the hands of most capable men, every stage of its development has been carefully canvassed, the experience of the existing industries on both sides of the Atlantic can be profited by, and the plant will be all of the most modern and improved type, the men selected for the control of every phase of the undertaking being the best that money could procure in their respective professions, and all being animated by the desire to make this new venture one of world-wide repute.

The works are located on a large area of unoccupied land east of the town of Sydney, affording an ideal site for the purpose. It comprises 494 acres, with a waterfront of a mile and a quarter, and the municipality of Sydney purchased it for $83,000 and presented it to the company as an inducement to the selection of the town as the home of the works. Ground was broken in June, 1899, and an army of men being employed, the transformation of this waste area into the seat of a mighty industrial enterprise is rapidly proceeding. The several divisions of the undertaking are well advanced. The complete plant is as follows:

Eight batteries, of 50 each, of coke-ovens, making 400 in all. These are on the Hoffman bye-product system, of the latest type, and designed for the saving and utilisation of all the bye-products of coal, which go to waste in nearly all the American smelters. The total capacity of these ovens will be 1,600 tons of coke daily. To produce a ton of coke will cost about 40 cents, but it will yield bye-products worth about 70 cents, of which the sulphate of ammonia will be sold as a fertiliser, the coal-tar will be disposed of for commercial purposes, and the illuminating gas will be used in the steel-making later.

Four blast furnaces, each of a capacity of 350 tons, or 1,400 tons in all. These are duplicates of the latest set up at Pittsburg, and admittedly the best in America. They are 85 feet high and 19 in diameter.

Ten 50-ton open-hearth steel furnaces will be set up for the manufacture of steel. Open-hearth steel is increasing in favour on the American continent to such an extent that it is felt that this quality will yield the best returns. The capacity of these furnaces will be about 1,100 tons a day, 400,000 tons per annum. The steel will be made from both the pigs and the hot metal. A rolling mill is also proposed, and piers, wharves, machine and repair shops, and other accessories will be provided as fully as the growth of the works demands.

The United Coke and Gas Company, of Pittsburg, Pa., are the contractors for the erection of the coke ovens. The Riter-Conley Company, of Pittsburg, U. S. A., have the contracts for both the blast furnaces and the steel mill. Their contract is all-embracing, and the figure is just $5,000,000, probably the largest single contract of the kind ever awarded. They will also provide 12,000 horse-power boilers, and five of the largest blowing engines ever constructed; six electric cranes and an electric plant for light and power. Their contract requires 13,000 tons of steel and iron work, and 15,000,000 bricks.

At the head of the steel company is Mr. H. M. Whitney. The vice president and general manager is Mr. A. J. Moxham, an Englishman who founded a large steel plant at Lorain, Ill. The consulting engineer, under whose supervision the whole plant is being established, is Mr. Julian Kennedy, who was consulting engineer at Carnegie's Pittsburg works, and who is among the highest authorities in the United States on such matters.

THE MACHINISTS' STRIKE IN THE UNITED STATES.

A SYMPOSIUM OF THE OPINIONS OF LEADING EMPLOYERS.

UNWELCOME as the admission is, it must be acknowledged that the strike of the machinists in the United States is sharp disappointment to the advocates of association and conference as a means of averting labour troubles. One year ago this month we published the "New York Agreement" between the National Metal Trades Association and the International Association of Machinists, an an example of the adjustment of labour troubles by common-sense agreement and arbitration between employers' and employees' organisations. True, we felt compelled even then to add that the millenium was not yet—that "the labour union, in its present form, is not a very responsible organisation, and shows a tendency to profit by its intangibility too often to establish a very strong feeling of confidence." It is distressing to find within twelve months that the fears, rather than the hopes, have been realised.

And yet this very distress embodies a germ of consolation. It was the neglect and abuse of the principles of organisation and conference, not reliance upon those principles, which precipitated the trouble. The most deplorable result of the difficulties would be abandonment of the policy of arbitration so promisingly inaugurated a year ago.

The general history of the trouble is widely known. It is recapitulated, with most generous allowance to the men's position, in Mr. Nelson's letter below. Briefly, it is that over a question of wages—heretofore mutually recognised as necessarily a matter for local adjustment—the men have attempted to force a general action by a general strike, thereby violating the fundamental agreement between the employers' and employees' organisations, which was that no strike or lockout should be declared pending discussion of points of difference, or until conference and arbitration had failed. The manufacturers therefore resolved that by officially refusing arbitration and ordering strikes "the International Association of Machinists has wilfully violated its agreement of May 18th, 1900, and having made the same NULL and VOID, the agreement is no longer binding on the National Metal Trades Association." They have declined further dealings with an irresponsible union, taken firm ground for individual treaty with their men, and in conference at Chicago on May 29, adopted their widely quoted "bill of rights," since adopted in other cities.

The fact, however, that the initial question (of wages) is so essentially a local issue, has led to great diversity of individual action and attitude. With a view to giving a comprehensive review of the entire field, THE ENGINEERING MAGAZINE has invited expressions from a large number of representative firms in all parts of the United States. Their opinions, quoted below, will be found of the highest interest and value. Mr. Nelson, of the N. O. Nelson Manufacturing Co., of St. Louis—a concern widely noted as a pioneer in efforts to establish harmony between labour and its employers—is placed first as being most comprehensive in his review of the case. Mr. Nelson says:

> "The machinists demand a 9-hour day with no reduction in the day wage. The associated manufacturers (by the New York agreement of May, 1900) agreed to a 54-hour week, effective May 20, 1901. The wages question was not mentioned; it was purposely omitted; it was considered a local question subject to various conditions, not subject to national action. Under this construction the machinists submitted local agreements covering wages and other matters. The employers' association in their April annual meeting decided unanimously that these agreements should not be signed, but should be referred to the general office and the unions so notified. * * *
>
> "The association's committee said further that its members were prepared to arbitrate the wages question in each individual dispute and date the award back to May 20th, to which the union president objected that the wages question had never been made part of the argeement to arbitrate, that it was now too close to the date (nine days) when the change in hours and pay took effect, that the men could not be expected to work several months at reduced pay pending arbitration, that local arbitration in innumerable cases (practically all shops) would place the workmen at disadvantage with their more astute and resourceful employers, and, finally, that a strike would be ordered wherever the local members of the two associations failed to adjust."

The machinists' position, even thus fairly summarised, does not command assent. There was no codified list of matters which should be arbitrated, but a general agreement that every difference should be adjusted without stoppage of work—by conference if possible, if not, by arbitration—with no general resort to strike or lockout until all peaceful measures had failed. The employers offered to adjust an admittedly local matter by the accepted local instrumentalities; the machinists rejected the agreement they had pledged themselves to accept, on grounds which are mere quibbles and not even plausible.

"The strike was ordered, union and non-union machinists co-operated, and so did association and non-association employers. Perhaps one-third of the capacity of the country made no opposition to the shorter day or week at the old pay; others settled at from 6 to 12 per cent. on the former hourly rate.

At a called meeting of the administrative council of employers, the agreement of a year previous was abrogated on the ground of violation by the union. In the meantime strikes and lockouts have practically closed the shops of Chicago, Milwaukee, Dayton, Cincinnati, and partially closed other cities. The employers' association has changed from arbitration and conciliation to defence.

"The principle of arbitration is apparently on trial, but in reality the disputants are only going through the kindergarten stage of industrial adjustment. They have yet to learn that chips on shoulders, lockouts, and strikes do not pay and settle nothing. What they cost is gone forever, and a sore spot remains. Also they must learn that arbitration is applicable to some questions and not to others. It is not applicable to general changes in hours and wages.

"A large portion of the employers of the United States believed in the shorter day and gave it cheerfully on or before May 20th. They knew that a reduction in daily wage in these prosperous times was not reasonable and would not be satisfactory, hence they continued the old day rate. To this number additions kept coming, partly from the pressure of business, partly from negotiations with their men, and partly from the conclusion that a 9-hour day of steady work is enough. Individually, a large majority of employers believe that the 9-hour day at the old pay is fair; those of them who object do so on the ground that it is not universal and would put them at a disadvantage. In fact, their advantage is to go peaceably on with their business, and should the movement fail, they can go back to the longer day with better grace than those who fought it out."

The belief in the eventual prevalence of a 9-hour day is indicated by some of our correspondents, in spite of the generally entertained view that it would be fatal to the ability of the United States manufacturer to compete in export markets. One concern in a city of the middle western States, which has stood almost alone locally in granting the men's demands, puts it thus:

"The most that we can say about the future prosperity of foreign trade with the United States is, that quite a per cent. of our business is foreign, and we did not hesitate to grant our men the increased pay and shorter hours as soon as the agitation became serious. Our men have not been out of the shop; we have not lost an hour's work, and we do not feel that the additional money we are paying the men will jeopardize our business in any way."

A large ship-building concern on the Atlantic coast puts it more qualifiedly:

"If this demand (10 hours' pay for 9 hours' work) could be met by simply granting the machinists' request, it possibly might be a matter for ship-building concerns to give consideration; but it would be simply an opening by which they would then on the request of 120 men have to raise the wages of 2,000, making a reduction of 10 per cent. in their output and an increase of 10 per cent. in their wages. This, taking everything into consideration—piece work, etc.—would mean an increase of between 7 per cent. and 8 per cent. per year. This under the circumstances and the long-time contracts ahead, taken on 10 hours a day and pay basis, would be impossible for any ship-building firm to accede to.

"We are of the opinion that nine hours will be a day's work eventually, but it will come by the process of evolution and not that of revolution. If this thing continues to spread, which we doubt, the result would probably be as disastrous here, in our opinion, as have been the results of the trade unions in England.

In general, even more clearly than in the instance above, the replies are indicative of the recent rapid growth in the business aims and market aspirations of the United States manufacturer. He measures local conditions by their influence on his competitive position abroad, or by their tendency read in the light of British or Continental experience. The former point of view is adopted by Mr. Walter Wood, of R. D. Wood & Co., of Philadelphia:

"The question seems to me to be how many hours can men comfortably work? Whatever this may be, there will be somewhere in the world earnest and active men who will stand ready to work that many hours and they will be those who succeed in securing trade in the long run from their fellows.

"Referring to the present situation I should feel that it was a mistake for the good hearty men of the United States not to be willing to work ten hours and to put in their pockets the money that comes from ten hours' labor, and enable the manufacturer with whom they work to be in better position to secure the trade of the world, for which, sooner or later, every one will be striving when dull times come around. Hence I would sincerely regret to see this country do anything that would weaken the lead it has already secured."

Another large house, internationally known as makers of machine tools and located in the same section of the United States, put it thus:

"We believe that the effect of the present wage struggle on foreign trade will be to greatly decrease, if not entirely prevent, any exportation of machine tools such as we manufacture. We should think that it would have the same effect on all tool builders; that is, supposing that the machinists gain their fight for the shorter working hour at the higher rate of wages. The cutting out of foreign business will seriously affect prices in the home market unless the cost of labor is reduced promptly to the old level."

A Cincinnati manufacturer, largely interested in the export of machine tools, says:

"The strike undoubtedly is affecting adversely the domestic market, and as a settlement of the strike will undoubtedly mean an increase in the cost of manufacture, it will also affect adversely the foreign trade."

But a graver note is sounded in the following communications, which we are permitted to quote over the writers' signatures. It is a forecast of the more paralysing encroachments of that unwise trade-unionism which has been Britain's bane. They are as follows:

BROWN & SHARPE MFG. CO.
Providence, R. I., June 4, 1901.

Editor of The Engineering Magazine. *Sir*:—

"We think we are all agreed here at present that the exact stake at issue is to unionize all the shops in the United States. That is only a prelude to the unions' undertaking later on the management of the machine business. The effect of that can easily be seen by studying the situation in Great Britain. It will cripple the domestic demand for machinery and make it harder to compete with foreign countries on account of the excessive cost. The struggle in the spring of 1900 had the same thing in view that they have now."

Very Truly Yours, R. Viall, Supt.

THE LODGE & SHIPLEY MACHINE TOOL CO.
Cincinnati, O., U. S. A., June 3, 1901.

Editor of The Engineering Magazine. *Sir*:—

From our point of view, the issue is the breaking of the perfectly explicit written contract and the determination of the organizers of the union to unionize the machine shops of the United States. We believe that the talk of increased pay and shorter hours is merely dust for the eyes of the manufacturers and that the cry of increased pay and shortened time is necessary for the leaders to carry the men with them to accomplish their purpose."

Very Truly Yours, The Lodge & Shipley Machine-Tool Co.

We can perhaps best sum up the position of the farthest-seeing American manufacturers in the words of Mr. H. W. Hoyt, of the Allis-Chalmers Company, Chicago, whose fair and liberal discussion of the labour-question in our issue of May, 1900, will be recalled with pleasure by our readers. Mr. Hoyt says:

"From my point of view, the conditions existing are directly traceable to a broken agreement, solemnly entered into between the National Metal Trades Association and the International Association of Machinists in May, 1900. The writer of this letter was one of the earliest advocates of arbitration and conciliation, and took a very earnest effort in starting the negotiations here in the city of Chicago which resulted in the New York agreement, above referrèd to. The abrogation of that agreement within a year has not only been a serious disappointment, but augurs badly for the future. In connection with the growing limitations placed upon shop output and increasing interference with shop management, I can see, if this programme continues, that American supremacy in the manufacuring world will soon be a thing of the past.

"I had supposed that the relations between the manufacturers and machinists had been placed upon a business basis. This hope I have at present abandoned, but I am not prepared to believe that eventually some national plan of adjusting difficulties will not be restored."

As we go to press, the situation is growing worse, rather than better. A bitter struggle is presaged—but possibly a short one, as the machinists' financial position is weak and the employers' moral position strong. Altogether it is a deplorable display of trade-union follies, in melancholy contrast to the exhibition of the potential good of organisation made last year.

EDITORIAL COMMENT

Several months ago (March, 1901) there appeared in THE ENGINEERING MAGAZINE a paper by Mr. Charles Rous Marten discussing the performance of American locomotives on British railways, and this is recalled by the remarks of Sir Alfred Hickman recently in Parliament, criticising the purchase of American locomotives for Indian railways, as well as the placing of orders for structural work with American firms. So far as the locomotive question is concerned, Sir Alfred tells us nothing more than Mr. Rous-Marten has already said; in fact, he does not tell us so much. The American locomotives in India are charged with requiring more repairs and consuming a greater quantity of fuel than English engines, and this, Mr. Rous-Marten told us several months before, was said of the American locomotives in England. At the same time he called attention to the indefinite character of these reports, and emphasised the difficulty of obtaining anything like a true idea of the coal consumption of either English or American-built engines, while Lord George Hamilton, in answer to Sir Alfred Hickman, says, speaking of the American engines in India: "the earliest reports were unfavourable, but when their working was better understood, and alterations were made so as to suit the local fuel, a marked improvement was noticed, so much so that one company wishes to obtain more engines of similar construction."

With regard to the Gokteik Viaduct, upon which it is charged that defective rivetting has been permitted, Lord George Hamilton says: "A most searching inquiry and inspection, made by the chief engineers of the Burma Railway Company, assisted by the Government's inspector, has satisfied the Railway Board that the work upon the bridge is sound and reliable."

Something more earnest than superficial criticism of allotted contracts is necessary, if the question of the loss of orders to British firms is to be satisfactorily answered. Lord George Hamilton is much closer to the mark when he says: "The competition we have to meet is founded on something more formidable and substantial than misunderstandings. Chemical research, concentration of capital, thorough technical education, improved industrial organisation, have made in recent years greater advance in America than here; it is with the product of these combinations and not with the assumed stupidity of Indian officials that the British engineer has to contend."

* * *

Mr. Morgan, magnified and multiplied by the fevered brains of sensation mongers and sensation seekers, is as multiform and as horridly ubiquitous as the Spanish fleet off the New England coast in the summer of 1898. He is seen simultaneously rushing east and dashing west, the smoke of omnivorous consumption trailing behind him and the bone of the world's trade in his teeth. The cartoonist shows John Bull nailing down his islands by their corners; the New York papers pretend that the Court is in fear lest the financier, taking a fancy to Windsor, should buy it off-hand; but it remains for the London *Express* to find the most fearful mare's nest of all, with a wild brood of nightmares, incubi, hippogriffs and chimeras just hatching out.

"An engineer of international distinction" has travelled the Continent in Mr. Morgan's service, buying navigable waterways, rights, franchises, inventions, patents, and systems of propulsion. All that is worth anything in the canals of Germany, Belgium, and Holland he has acquired. Apparently, also, he has bought the Prussian Diet, the Kaiser, and the Russian Government, and set them at work extending the canal system in his interest. Meantime he has not been idle at home. The Erie Canal and the monopoly of electric canal-traction have been gobbled. Niagara, from shore to shore, has fallen into his hands. He has effected a Siamese junction with Vanderbilt; together they own Depew and Platt, Depew and Platt own the Senate, the Senate owns the United States, and all legislation and subsidies are Morgan's. He has not bought the ocean as yet—at least the narrator forgets to mention it; but with American canals, subsidised steamships, and Continental waterways all knit in his firm grasp, he is going to send his steel "far into the heart of Europe by water solely. Cargoes will be carried from mill to buyer without a break in bulk or a penny's expense for railway charges." We quote the *Express* accurately in summarising this marvellous scheme.

Marvellous is indeed a wholly insufficient term for the craft which float through the dream of the seer of the *Express*. Versatile, amphibious, behold them starting from Pittsburg straight overland two hundred odd miles, to get into the Erie Canal at all; floating down its seven-foot channel through the Hudson to salt water; putting fearlessly out to sea (supported by a subsidy); and finally entering and ascending the Continental canals, which have a limiting depth of 2.2 metres! With what pride of power would they make light of the rugged climb across the ridges of the Pennsylvania hills, usually so inconvenient for marine craft! With what sleek satisfaction would they contemplate their elastic build, adapted to the small locks, the shallow draught, and the low bridges of the canal, yet stable in the storms of the Atlantic! With what proud satisfaction would they discharge their cargo at the buyer's door, unbroken in bulk since it left the Pittsburg mill! With what thirst load again at the brewery with Münchener or Pilsener for a profit-bringing cargo on the long journey by canal, sea, and dusty roadway, home! Truly, of all Mr. Morgan's gigantic schemes, the *Express* has unearthed the most marvellous!

* * *

A striking example of what has been termed the "scrapping" of costly machinery while yet in perfect condition is seen in the recent transformation of the tramways in New York from cable to electric traction. It is estimated that the Broadway, Columbus Avenue, and Lexington Avenue cable plants cost $16,000,000. Of this amount about $10,000,000, represented by tracks and real estate, is still available, the remaining $6,000,000, through no fault of its own, having been doomed to the scrap heap simply because it has been superseded by more efficient appliances. In the case of the Third Avenue line, in the same city, recently transformed from cable to electric traction, there was a similar scrapping of property valued at $8,000,000. so that the total extent to which the Metropolitan railway system of New York has carried out this idea is represented by the sum of $14,000,000.

This is probably the largest example of the application of the modern method of prompt depreciation which has yet occurred and as a lesson to manufacturers it is full of meaning.

How best to provide for this supercession which takes the place of what was formerly termed depreciation, is a serious question. The establishment which adds to its factory costs a depreciation charge sufficiently high to sink the cost of the machinery in the time during which it can probably be profitably worked, may find the apparent profits seriously diminished, or the prices forced up to an impracticable extent. On the other hand, the manufacturer who does not thus provide for his depreciating plant, is really in a "fool's paradise," drawing dividends out of his principal while fondly imagining that they have been earned. It is a problem which many a works manager has to face, and those who have not the courage to meet it boldly, may find it all the more difficult to meet because it has been postponed.

REVIEW OF THE BRITISH PRESS

American and British Rolling-Mill Practice.

THE conspicuous feature at the recent meeting of the Iron and Steel Institute was undoubtedly the paper of Mr. William Garrett, comparing the practice of England and America in the operation of rolling mills. The paper was a strong arraignment of British practices, endeavoring to show the cause for the superior economy and increased output of American mills, and it naturally drew forth many replies and provoked an active discussion.

Mr. Garrett, although British by birth, is American by adoption and experience, while at the same time thoroughly familiar with British practice, and hence altogether in a position to know what he is talking about, and this, as well as the nature of his subject doubtless had much to do with the attention which his paper excited. Taking up in succession the topics of blooming mills, rail mills, tin plate bar mills, mills for structural steel, for merchant iron and steel, hoop mills, and wire-rod mills, he proceeded to compare the practice of America and Great Britain. Starting with the statement that the supremacy of Great Britain in the iron and steel trade has been lost, and that large quantities of foreign raw and finished material are being imported, Mr. Garrett assumed that something must be wrong with the British method of making Bessemer steel ingot, and rolling it into billets.

Comparing the practice of Great Britain and America in the matter of blooming mills, it appears that there is a decided advantage in making 4-inch billets, as in the United States, over the smaller sizes common in British practice, it costing practically as much in labor and establishment charges to make a 2-inch as it does to make a 4-inch billet. There is also a great advantage in the American system of keeping an exceedingly close watch upon every minute of time and the care which is taken to keep the mill continually full of material.

Taking up the question of rails, Mr. Garrett thinks that although the reversing mill is the best for billets, the three-high mill is superior for rails. The principal reason why British mills do not give so high an output as American mills is again due to the manner in which they are run. In America the rail mill is kept full of steel from six in the morning until six at night; with two bars in the roughing and two bars in the finishing at the same time, and if similar activity cannot be maintained in England the maximum production cannot be expected.

In no class of material has the loss of work to Great Britain been more marked than in tin plate bars. Prior to 1892 there was a demand in America for about 350,000 tons of tin plate per annum, calling for about 550,000 tons of tin plate bars every year, this being about 75 per cent. of the total British output. Nearly all the trade in bars involved in this has been lost, and tin plate bars of American make are being pushed right into British tin plate districts in 1,000 ton lots. This is entirely the result of the use of specially designed machinery, in which all the work, from the ingot to the finished bar placed on the cars, is done by machinery.

The methods of production of structural steel are so nearly alike in both countries that there is occasion for little notice, the work being about fairly divided between the three-high mill and two-high reversing mills.

In the case of merchant iron mills, the absence of competition, and the presence of plenty of orders has caused equipment to fall behind the times in England. Mr. Garrett made the astonishing assertion that during the past ten years all of the British iron and steel manufacturers together did not spend as much money on improvements as the Carnegie Steel Company did in two years. This in spite of the fact that nearly all great ideas which led to improvement came from England. The Bessemer, the Siemens, and the basic processes all came from England. It is to Bedson that the continuous mill is due, to Allen, the heating furnace for billets, to Ramsbottom, the reversing mill, all of them Englishmen. In merchant steel no mills especially adapted to the work have been built in Great Britain, while in America great attention has been paid to this. Merchant mills with continuous trains, using the Allen furnace with Laughlin dropping-out arrangement, are producing as high as 445 gross tons of 1⅛ finished square bars in 24 hours, requiring only four men, and such mills have produced more than 8,000 tons in a single month.

The rolling of hoop iron has been carried to a high degree of perfection in the United States, and Mr. Garrett says that he considers the continuous hoop mill at Youngstown, Ohio, designed and built by the Morgan Construction Company, to be the finest rolling mill machinery in the world. This mill, which owes many of its distinctive features to a Welsh engineer, Mr. Edwards, takes a 1½-inch billet, 30 feet long, weighing 225 pounds in at the first train, and delivers it as 20 gauge hoop, ⅞-inch wide, coiled as neat as a ribbon, the only manual labor being that of a boy who takes the first end with a pair of tongs and enters it into the reel.

As to rod mills, it is only neces ary to mention the continuous rod mill designed by Mr. Daniels, which starts with a 4-inch billet and has an output of about 350 tons to the double turn.

Taking the rod mill as a basis for comparison, Mr. Garrett asserts that the four best rod mills in Great Britain, during the month of January, did not produce as much as one of the wire rod mills in the United States, which, during that month, produced 10,230 gross tons of No. 5 rods. Taking five British mills to equal this American output, a comparison of wages shows that the labor cost was 75 per cent. less for the American product than for the British.

This is but one of a number of comparisons which might be made, but it is significant, and is the warrant which Mr. Garrett gives for his conclusion.

"If the British iron and steel makers do not follow the example of their American cousins and combine, and then only manufacture their respective material at the most advantageous points for shipment, and use the most economical methods in manufacturing, the manufacture of iron and steel will, in time, become a lost art in Great Britain."

While the discussion elicited by this trenchant paper did somewhat to modify details advanced, the main principles remained untouched. Indeed, the whole trend of the discussion appeared to be defensive; hardly the proper manner to examine a subject by no means intended as an attack. It is only by such presentations of the facts relating to competition that that competition can be met, and the opportunity of obtaining the full account of the methods of rivals as given by Mr. Garrett is one which is rarely met, and in most instances would be eagerly welcomed, and promptly heeded.

The Proportions of Multiple-Cylinder Engines.

In a paper recently read before the Civil and Mechanical Engineers Society, Mr. Alfred Hanssen discussed the mooted question of the proportions of cylinders for multiple-expansion steam engines, and brought out some points of practical value to the designer. The questions involved in successful design of such engines is the attainment of the highest possible steam economy, together with an equal distribution of the power between the several cylinders. The equal distribution of the work is of most importance in cases where each cylinder is connected to a separate crank, and where the load is constant. The attainment of steam economy is always desirable, but depends upon several factors, of which cylinder proportion is but one.

Before considering the best proportions for the cylinders, it is therefore important to see that other conditions affecting economy have been provided for in the best manner. Tests of multiple expansion engines of good proportions, but which have not shown the steam economy which might have been expected, have revealed the fact that the presence of water in the cylinder was the principal cause of the large steam consumption. This presence of water may be due to priming, to cylinder condensation caused by radiation, and to the defective drainage of the cylinders. Priming must be remedied at the boiler, radiation can be greatly minimised by ample use of heat-insulating lagging, while drainage is largely a mechanical problem. Professor Perry has pointed out that steam of 100 pounds pressure per square inch condensed in the steam cylinder and drained off before it has had time to re-evaporate, will impart 1054 thermal units per pound of steam to the cylinder walls, but if this water is re-evaporated during the exhaust stroke as a temperature of 142° F., only 60 units will be imparted to the cylinder walls.

The maximum amount of work can be obtained with the least expenditure of heat when dry steam is expanded without gaining or losing heat from the cylinder walls. The volume of steam in this case increases, not as in isothermal expansion, nearly inversely as the pressure, but inversely as the 0.88th power of the pressure.

With large engines at high piston speed the adiabatic expansion curve may be closely approximated in practice, and hence this may well be taken in determining the cylinder proportions. By constructing the curve for the pressure and total expansion ratio and then dividing this diagram vertically into parts corresponding to the number of cylinders to be used, the cylinders being taken in geometrical progression; also dividing the diagram horizontally into four parts each representing the initial pressure in the corresponding cylinder, rectangles are obtained. These rectangles are of equal areas and each contains an indicator diagram of nearly equal area, and from these diagrams the cut-off, drop, and other particular can be easily measured, and the valve gear adjusted accordingly.

Mr. Hanssen gives a practical example of the method as applied to a quadruple expansion engine, showing its convenience in actual design.

Syntonic Wireless Telegraphy.

In the March issue of The Engineering Magazine, a review was given in these columns of the method and apparatus devised by Professor Slaby, of Berlin, for the purpose of rendering messages sent by magnetic waves over space, non-receivable by any except those for whom they are intended. This has been followed by a paper by Signor Marconi, read before the Society of Arts on May 15, and published in the *Journal* of the society, with diagrams showing how he had already solved the problem, and indicating the methods employed by him.

Mr. Marconi explained his silence as to his work in this direction by calling attention to the fact that business conditions required caution in making public devices which were in process of patent protection, but the dates of his experimental work and of his patents appear to bear out very conclusively the manner in which he has anticipated Dr. Slaby in obtaining multiple space telegraphy.

Without going too deeply into the constructive details of the apparatus by which messages may be sent from one transmitter to its corresponding receiver without affecting other receivers or being affected by other transmitters, it will be practicable to explain the principle upon which the method is based. In the early forms of transmitter electrical waves are radiated from a simple straight rod in which electrical oscillations are set up. These oscillations, however, die away with great rapidity, ceasing, not necessarily by resistance, but by electric radiation removing the energy in the form of electric waves.

Now, if a receiver is tuned to respond to electrical impulses of a certain period, the oscillator by which such a receiver is to be affected must be persistent in the periodicity of its impulses, just as a heavy pendulum, to be set in motion by small impulses, must receive those impulses at intervals timed to the period of oscillation of the pendulum. As Dr. Fleming remarked, a cork, floating on water will be bobbed up and down by any wave, long or short, but a heavy log of wood floating on the water and tethered to the bottom of the sea by a spiral spring would only be caused to bob up and down by waves having one particular period.

Mr. Marconi described, with the aid of numerous diagrams, his successive steps toward the development of a form of transmitter adapted to the emission of waves of constant or tuned periodicity, several successful forms having been produced. The tuning of the oscillation transformers on the receivers was effected by winding them with varying lengths of wire in their secondary circuits, thus causing them to be in tune or resonance with the length of waves of any selected transmitted oscillations. This being done it was possible to obtain selection of messages with the ordinary transmitter when using two or three transmitters having wires of considerably different lengths; but this is only a very incomplete solution of the general problem. It was therefore necessary to increase the capacity of the radiating system, and this was accomplished, in one form of the apparatus, by placing near the ordinary vertical radiator, an earthed conductor, this increasing its capacity without increasing its radiative power. This was then improved by making the radiating and resonating conductors take the form of a cylinder, the earthed conductor being placed inside, and a great increase in efficiency followed this arrangement. In this form, Mr. Marconi presumes that it is essential that there should be a difference in phase of the oscillations of the two conductors, as otherwise their mutual effect would be to neutralize each other.

By using similar conductors in connection with both radiating and resonating instruments it is possible to cause the electrical period of oscillation of the receiving cylinder to correspond to that of one out of several transmitting stations, from which one alone it will receive signals. The closely adjacent plates and large capacity of receiver cause it to be a resonator possessing a very decided period of its own, no longer apt to respond to frequencies which differ from its own particular period of electrical oscillation, nor to be interfered with by stray waves, which are sometimes probably caused by atmospheric disturbances, and which occasionally prove troublesome during summer. Another advantage possessed by such cylinders is the very moderate height required, compared with that formerly demanded by the simple conductors.

Another variety of transmitter has been constructed by associating with the radiator wire a condenser circuit, this forming an oscillator which sets up very persistent oscillations in the transmitting vertical wire.

Still another form employs a circuit including a condenser together with the primary of a Tesla coil, the secondary of which is connected to the earth or aerial conductor. With this is used a receiver tuned to the frequency of the oscillations set up in the vertical wire by the condenser circuit. In this form it is essential to tune to the same period of oscillation the two electrical circuits of the transmitting arrangement, these circuits being the circuit consisting of the condenser and primary of the Tesla coil or transformer, and the aerial conductor and secondary of the transformer. The receiver consists of a vertical conductor connected to earth through the primary of a transformer, the secondary circuit of which is joined to the coherer. An adjustable condenser is placed across the coherer, increasing the capacity of the secondary resonating circuit of the transformer. In the case of a large series of comparatively feeble, but properly timed oscillations being received, their effect is summed up until the electromotive force at the terminals is sufficient to break down its insulation and cause a signal to be recorded.

Mr. Marconi goes somewhat into detail as to the windings and lengths of vertical conductors required to effect proper tuning, but for this and for the numerous diagrams the original paper must be consulted. It may be mentioned, however, that the length of the vertical conductor has been greatly diminished as compared with that formerly required, and on a portable apparatus installed on a steam motor car it has been found that a cylinder about 20 feet high, which can be lowered when traveling, enables signals to be communicated to stations more than 30 miles distant.

It is intended to provide the syntonic system in all future installations of space telegraphy, for, as Mr. Marconi remarked, "The ether about the English Channel has become very lively, and a non-tuned receiver keeps picking up messages or parts of messages from various sources which very often render unreadable the message one is trying to receive."

In commenting on Mr. Marconi's paper Professor Ayrton said that we were gradually coming within thinkable distance of the realization of a prophecy he had ventured to make four years before, of a time when if a person wanted to call to a friend he knew not where, he would call in a very loud, electro-magnetic voice, heard by him who had the electro-magnetic ear, silent to him who had it not. "Where are you?" he would say. A small reply would come: "I am at the bottom of a coal mine, or crossing the Andes, or in the middle of the Pacific." Or, perhaps, in spite of all the calling, no reply would come, and the person would then know that his friend was dead. Think of what this would mean, of the calling which goes on every day from room to room of a house, and then think of that calling extending from pole to pole, not a noisy babble, but a call audible to him who wants to hear and absolutely silent to all others. It would be almost like dreamland and ghostland, not the ghostland cultivated by a heated imagination, but a real communication from a distance based on true physical laws!"

The Present Position of the Mechanical Engineer.

In the course of his Presidential address recently delivered before the Institution of Mechanical Engineers Mr. William H. Maw touched upon many points of importance bearing upon the present practice of mechanical engineering, and although it is impossible here to cover the entire field, some abstracts may be given.

The extent to which mechanical engineering enters into our daily lives is most inadequately appreciated by the average citizen. As a matter of fact there is scarcely a moment during which we are not indebted to the mechanical engineer for our necessities and comforts. Clothing, food, sanitation, transport, all are included in the immediate scope of mechanical engineering, while if more remote connection be considered the list might be almost indefinitely enlarged.

Touching briefly upon the question of technical education Mr. Maw considers the connection between the preparatory school and the technical college as a kind of crossover road, in which the transition from the line of scholastic training to that of independent thought and action should be effected as smoothly as possible.

"Nothing is more disheartening to a student than to find at some stage in his career that he has been devoting time to learning things which are not only useless to him, but which it is really desirable that he should un-learn; while, on the other hand, he has failed to acquire knowledge of which he stands badly in need. Yet this is a far too frequent experience with boys entering technical colleges from our public schools. Matters are improving in this respect, and many of our large schools are conducted on less hard-and-fast lines than formerly, and are thus materially aiding the technical colleges in the early stages of their work. The changes, however, which have so far been made in this direction are of a very limited extent compared with those really acquired, and there is still left to be done at the technical college much educational work which ought to have been done at school, the result being a waste of valuable time. This matter is one which merits the most careful attention of all interested in technical education."

A still more important point in the career of the engineer is the junction between the college training and the future professional career. Here the technical college should be so conducted as to connect with the practice of the engineering establishment, as it is hardly to be expected that the latter will modify itself to suit the methods of the college. The principal defect of the technical college in this respect is found in the predominance which is given to a certain limited field of work, thus preparing men for lines already overcrowded.

"For some branches of our work, our colleges as they exist, afford an admirable training. Thus, the principles of steam-engine construction and working are usually very fully taught, and the student is rendered familiar with modes of testing both materials and motors, and other kindred matters. The result is that a student, entering works where steam engines are built, at once feels more or less at home; and he acquires a knowledge of shop work much more quickly and easily than he would have done had he not had his previous college experience. But the young engineer who enters some less-known branch—say, for instance, the construction of ordnance, of textile or milling machinery, or even of machine tools, such as are used in advanced practice—finds himself on far less familiar ground, and greatly in want of preliminary special training. In fact, he feels himself in the position already referred to as so undesirable—namely, that he has spent time acquiring knowledge which is of little immediate practical use to him, and that he has done this at the expense of not learning things which he badly wants to know. Of course, it is quite impossible for the educational equipment of our technical colleges to comprise plant relating to more than a very restricted number of branches of mechanical engineering work, while the knowledge of a staff of professors and the variety of the training they are capable of imparting are necessarily finite; but, notwithstanding this, it will be found possible to do much more than is now generally done to give a special character to the final stages of a college course, and to encourage students to take a wider view than most of them now do of the possibilities of the career upon which they are entering."

"It cannot be too thoroughly appreciated that the vast development of mechanical engineering work which has been going on in the past half-century, and which is still going on at an ever-increasing rate, is producing a most important change in the conditions which secure both professional and commercial success. In the old days, our leading firms of mechanical engineers had comparatively few customers; and they had, as a rule, to meet the great variety of requirements of those customers to the best of their ability. Repetition work was comparatively rare, and success depended largely on resourcefulness and the power of entering thoroughly into the conditions to be fulfilled. Nowadays, the successful mechanical engineer is not he who makes a great variety of things for the few, but a small variety of things for the many; at the same time producing those few things in the most perfect way. Such a manufacturer will not be confined to his own country for the sale of the machinery he produces, but will be able to supply the markets of the world."

The development of transport and of communication unite to enable us to draw supplies from all countries, and also accelerate to opening up of new countries as customers for engineering products. These influences, acting as they do for all countries, have greatly increased competition, and as a result of this competition methods must be modified and changed from those which obtained under earlier conditions.

Mr. Maw proceeded to discuss at length much of the work of the mechanical engineer in connection with standardising, testing, research work and specialisation, and emphasised the advantages accruing to all by such institutions as that over which he had been chosen to preside, and the whole address forms most timely and profitable reading.

The Boiler Committee's Report.

THERE appears in a recent issue of *Engineering* a communication from the Marquis de Chasseloup Laubat commenting upon the interim report of the water-tube boiler committee in a very interesting manner, and in view of the extensive theoretical and practical studies made upon the subject by the author, and his high standing in the engineering world in France, some abstract of his opinions will be of value.

The Marquis de Chasseloup Laubat speaks with entire impartiality upon the question of the Belleville boiler, he having been considered in France as being rather prejudiced against it at the time of the bursting of tubes on the Jaureguiberry in the Lagrafel and d'Allest boiler, and he then demanded that exhaustive experiments be carried out with the principal types under trial, instead of adopting the Belleville boiler exclusively.

Taking up the points of the interim report seriatim, the Marquis comments upon them carefully and judiciously, and although we cannot in all cases agree with his conclusions they are certainly entitled to much weight.

Admitting the superiority of water-tube over tank boilers for military purposes, it is hardly correct to maintain that at the time when the Admiralty decided to adopt water-tube boilers that there was none but the Belleville which had been tried to such an extent as to warrant its use.

The statement that the circulation of water in the Belleville boiler is "defective and uncertain" demands explanation. It is evident that no water-tube boiler can give results either satisfactory or acceptable, if it has not a sufficient circulation for a normal rate of combustion. The whole question therefore depends upon the rate of combustion. It is well-known that the Belleville boiler, or any boiler with "restricted" circulation will not stand forcing, and the fact that vessels fitted with Belleville boilers have run over thousands of miles without accident, while showing that the boilers did succeed in steaming at the rate of combustion at which those navigations were carried out, (a rather obvious conclusion) simply indicates how deliberately those navigations were conducted.

It is said that boilers such as the Yarrow, Thorneycroft, Du Temple, and others permit a more intense circulation than takes place in the Belleville boiler, and the Marquis replies that the Belleville was never intended to stand such intense rates of combustion as these express boilers, which is doubtless true. At the same time it must be remembered that the great object of introducing water-tube boilers into the naval service was to secure a form of steam generator which should permit immediate forcing to meet the sudden demands for steam so probable in naval evolutions. In such a battle as that at Santiago, in the Spanish-American war, the importance was seen of a steam generator which could stand an instantaneous demand for steam like the spurt of a race horse in the supreme moment of a contest, and a boiler with restricted circulation and consequent restricted firing and steaming capacity is utterly unequal to such demands.

Intense firing is altogether undesirable for cruising on long voyages or other deliberate evolutions, but if any piece of machinery is to be capable of overloading it should be capable through and through. A boiler with grate surface permitting a high rate of combustion, provided with a furnace adapted for forced draft, designed to withstand high pressures and emergency working, is after all no better than the old tank boiler for military purposes if all these advantages are destroyed because of defective circulation. All parts should be alike capable of meeting the call from the bridge for speed, and the open admission that the Belleville boiler "was never designed to meet such intense rates of combustion" is a plain statement of its unfitness for naval purposes.

In regard to the desirability of using automatic feed appliances, the Marquis is altogether right, and his opinion on that point is so clearly expressed as to render it desirable that it should be here repeated.

"In all modern machinery the tendency to-day is to secure safety by means of automatic apparatus, and not by a permanent attention of the staff in charge. More and more every day it is demonstrated that the human machine is the least trustworthy of all, especially in sudden cases of emergency; and, as men cannot be entirely dispensed with, it is being tried to reduce their duty to keeping up automatic arrangements. The continually increasing success of the United States competition against the Old World is mostly due to the fact that Americans—although they possess very intelligent and energetic workmen and engineers—carry as far as they can the principle and the applications of automaticity."

In closing, the Marquis thus sums up the interim report from his point of view, the point of view of probably the most capable and disinterested French engineer who could be named in connection with this most important subject.

"Water-tube boilers are to be preferred to Scotch boilers. Belleville boilers must be entirely thrown away.

"Nobody knows which type should be adopted in their place.

"Is it reasonable, fair, and scientific, to propose the radical abolition of an apparatus which, even in an imperfect manner, is the application of a necessary and indispensable principle without even knowing by what it may be replaced?

"I do not hesitate in answering, No. In my opinion the truth is just at the opposite of the conclusions of the interim report. Care must be taken not ultimately to condemn the Belleville boiler, before knowing whether there is a type of boiler which can give better results in actual service; it is absolutely necessary to carry on long practical experiments with the various boilers, the first trials of which have proved satisfactory.

"To sum up, I contend that even a defective solution of a problem must not be rejected, until it has been ascertained that a less defective one is at hand. I purposely say 'less defective', and not a 'better', because a marine boiler, as well as a warship, can only be a compromise.

Motor Vehicles for Heavy Traffic.

The progress of motor vehicles for heavy traffic in the past five years is well shown by the address recently delivered before the Liverpool Chamber of Commerce by Mr. E. Shrapnell Smith, secretary of the Liverpool Self-Propelled Traffic Association.

Besides giving out the details of the trials for the present year, a review was made of the results of previous trials showing how the defects revealed by those trials were subsequently overcome.

"It is generally well known how the wheels of the vehicles which competed in the 1898 trials proved structurally defective when subjected to the hammering action of granite sets and cobblestones, whilst other minor troubles, *e. g.*, with the condensers and in respect of adhesion, justified that 'sitting on the fence' which was the policy adopted by our Liverpool teamowners and shipowners, and by Lancashire manufacturers as a whole. The second trials, which took place in 1899 immediately prior to and in conjunction with the Liverpool show of the Royal Lancashire Agricultural Society, provided satisfactory evidence that the tyre and adhesion difficulties had been overcome, for none of the wheels gave the smallest trouble and five out of the six competing vehicles successfully climbed, both unladen and laden, Everton Brow, Brow Side and Rupert Lane, where the inclination varies between 1 in 9 and 1 in 13, the heaviest load taken up and brought down again being six and a half tons. Yet, these trials did not satisfy the judges that the time was ripe for any extension or general adoption of motor wagons, for in their conclusions of December, 1899, they say: 'The difficulties imposed by meeting the limit of three tons tare under the locomotives and highways act, 1896, were again serious drawbacks to ideal construction. The strength of frames and working parts, the area of bearing surfaces, the width of wheel tyres, the available platform area, the stoutness of the platforms and woodwork generally, and the diameters of axles and shafts, were consequently reduced below what is compatible with a satisfactory life.' "

"In order to see whether manufacturers could improve their designs so as to produce an efficient vehicle under the three-ton limit of tare, the association decided to allow an interval of two years between their second and third trials. The result has been that all the vehicles have grown heavier, and there is now another strong argument in favor of the desired increase. As a tentative clause in the act, that controlling the tare has served its end of forcing manufacturers to put forth their best efforts in design and workmanship, but it is hard to imagine why the tare weight should not have been equal in the first instance to at least that unit of traffic which the motor vehicle replaces, viz., a lorry and three horses weighing, say, four and a half tons. Of course there was no experience of this type of vehicle in 1896, seeing that only light pleasure carriages of foreign build and traction engines existed. There is, however, every reason to hope that the engineer inspector, who will represent the president of the Local Government Board at the forthcoming trials, will be clearly satisfied that the extra weight involves no risk and possesses many advantages. In fact, it is important that disabilities should be removed before the end of the present session, and it cannot be gainsaid that an increase is all-important for the future development of road haulage. This means improved internal communication, the improving of land in agricultural districts and the provision of a light railway to the very door of every farmer in the country. There is no doubt that Liverpool stands to benefit as much as, if not more than, any other city or port in the country, but it is equally certain that the advantages of mechanical transport will gradually be appreciated throughout the United Kingdom. The average daily mileage of a motor wagon, when upon straightforward work, is from thirty-five to forty miles, and, whilst this distance, measured from many of our ports, brings one into sparsely populated districts, such range of action opens up great possibilities for Liverpool and a few other ports in particular. There is at hand in the self-propelled lorry an inoffensive means of conveying raw materials or merchandise from point to point without the intervention of any handling or breaking of bulk, in addition to which cartages are absorbed into the one journey and terminal delays are avoided. No elaborate preliminaries are required; neither Parliamentary powers nor permanent way."

REVIEW OF THE CONTINENTAL PRESS

The Computation of Masonry Arches.

Although the arch has been the subject of study and discussion from early times, it is only in the past fifty years that its technical literature has assumed definite form, and in spite of the many works which have been written, the practical work of construction has generally been conducted according to empirical methods.

An exhaustive review of the computation of the form and equilibrium of masonry arches forms an important contribution in a recent issue of the *Annales des Ponts et Chausées*, by M. Legay, and some examination of his treatment is here given.

Nearly all writers upon the subject make the error of assuming the form of arch as given, and then proceed, by methods more or less intricate, to find the conditions of equilibrium resulting from various conditions of loading. M. Legay gives the credit for the first true conception of the nature of the problem to M. Denfert-Rochereau, who, in 1859, announced that the load alone should be assumed as given, and that from this, for any span and rise, should be computed the form and dimensions which should satisfy the following conditions:

1. That the resultant of the pressures should pass through the middle of each joint, thus giving a uniform pressure over the entire surface.
2. That the resultant of the pressures should act normal to each joint, thus requiring no resistance, such as friction, to be provided to oppose sliding.
3. That the pressure per unit of area should be the same upon all the joints, this requiring an area in each case proportional to the pressure upon each joint.
4. That the pressure per unit of surface should correspond to the greatest resistance which the material is capable of sustaining without alteration of its elasticity.

M. Denfert-Rochereau proceeded to solve the problem for a linear arch and having thus determined the form he drew the joints normal to the curve, giving a depth of voussoirs dependent upon the resistance of the material employed, but his analysis was very complicated besides giving only approximate results. The principal defect in his method was the assumption that the curve of equilibrium determined for a linear arch would be maintained for one of a determinate thickness, this really being true only when there are hinges at the crown and springings to compel the passage of the equilibrium curve through determinate points.

Taking up the points proposed by M. Denfert-Rochereau, and modifying them to correspond to the difference between the linear arch and the various possible arches of finite thickness of voussoirs met in practice, M. Legay proceeds to devolop the various equations necessary to enable the true equilibrium curve for a given loading to be determined. This curve, while corresponding in form and equation to the catenary, differs from it according to the loading, the position of the parameter depending upon the load. The result is what Rankine called the "transformed catenary," but which M. Legay has termed a "catenoid." By insisting on determining this curve in advance of the selection of the form of the arch, a most important point has been made, and this cannot be too strongly emphasised. The common, and wholly wrong-headed practice of selecting a form of arch and then endeavouring to determine the location of the line of pressure and the points of rupture, he proposes to replace by the rational method of determining the position and shape of the line of pressure about which any desired form of arch may be constructed.

The formulas deduced in the paper enable the curve to be constructed readily, especially with the aid of a table of hyperbolic functions. For ordinary masonry arches, constructed without hinges, the best plan is to consider them as built-in at the springings, this being generally in accordance with the facts, and thus reducing the arch proper to the middle portion and making it correspondingly flatter; and M. Legay gives, among other tables, those especially adapted to these conditions.

The principal defect in any analytical treatment of this problem lies in the limited number of conditions to which formulas and tables can be applied. The transformed catenary, to use Rankine's term, is only discussed analytically for a stationary load carried up to a given horizontal height above the key, while in actual practice various distributions of fixed load must be considered, and the moving load, especially in the case of railway bridges, must be examined.

Accepting all of M. Legay's premises, and affirming especially the position that the curves of pressure should be determined and the arch constructed about them, instead of assuming the shape beforehand, it should be considered that the graphical method affords a wider scope and greater certainty in results than any analytical method possibly can do. By constructing a force polygon for the stationary loading, which can easily be done, however irregular it may be in magnitude and distribution, and then adding to this the variations in shape due to the successive positions of the moving load, a core or kernel, within which all the equilibrium curves lie, is found, and about this kernel the actual arch may be drawn in such a manner as to bring the pressures practically normal to the joints and very near the middle of the voussoirs, thus fulfilling all the conditions of M. Denfert-Rochereau, and avoiding the elaborate analysis of M. Legay, while at the same time greatly extending the scope of the problem.

The Performance of Shearing Tools.

In the April issue of The Engineering Magazine there was reviewed in these columns the first portion of a study by M. Codron relating to the power required for various operations of machine tools, that portion relating to the performance of grinding tools.

This is now followed by two successive installations, published in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, examining in a very exhaustive manner the action of shearing tools.

The operation of shearing involves a certain degree of malleability in the material worked, wrought iron, for example, being suitable, and cast iron unsuitable, for this operation.

In the case of ordinary shearing, such as the cutting off of a bar of iron at the forge, using hand tools, the cutting tool acts as a wedge, the vertical force being opposed, not only by an opposite vertical force, but also by two lateral forces, acting in directions normal to the faces of the wedge-shaped cutting tool. These latter forces act to produce a longitudinal stress on the material, uniting with the cutting action of the edge to produce the desired separation. Besides these two actions there is a third, the friction of the surfaces of the tool upon the newly cut surfaces of the metal, this being a resistance which, while opposing the effort of the tool, does not correspond to any cutting effect.

In analysing mathematically the relations of these opposing forces, M. Codron calls attention to the fact that of the three resistances to the tool, only that which opposes the longitudinal tension upon the material is capable of calculation, the direct cutting action of the edge, and the friction of the surfaces of the tool upon the metal being indeterminate.

The angle of the wedge which constitutes the tool is an important element in determining the resistance, and this angle may vary from 20°, for a soft metal, such as lead, to as high as 70°, for iron, the more obtuse angles being necessary in order to prevent the breaking of the tool.

The resistances to shearing are naturally different at different stages of the operation, the first effect being limited almost entirely to the penetration of the cutting edge below the surface of the metal. Further progress causes the other resistances to assume a proportionally greater influence until a maximum is attained before the piece is entirely sundered, this point varying with different materials and tools, the concluding portion of the operation showing a continually diminishing resistance until the operation is completed.

In order to examine the action of shearing tools in detail, M. Codron has studied the manner in which such a soft metal, such as lead, behaves, and by employing accurate testing machines, and plotting the forces under various conditions as curves, he has deduced the general manner in which shearing of metals is effected. Similar investigations with copper, with iron, and with steel, the general co-efficients for the resistances of cutting and of friction being thus experimentally determined, for various angles of tools.

By plotting the results, using ordinates to represent pressures upon the tools, and abscissas to show the penetrations, the relations of the forces are very clearly shown, and by scoring the surface of the test piece with vertical and horizontal lines it is possible to observe the extent of the deformation of the material in the vicinity of the sheared section.

For the details of the various tests reference must be had to the original papers, but the general results may be indicated and some conclusions drawn.

The curves plotted as above indicated, giving the relation of pressure and penetration are very nearly parabolas, and as the areas included measure the work performed, the work may be taken as equal to two-thirds of the product of the maximum pressure and the total penetration. For thicknesses below 15 millimetres the maximum pressures are very nearly proportional to the cross section of the test specimens, while for greater thicknesses the required pressures are greater.

For a very ductile material, such as lead, the cutting action is maintained nearly through the entire thickness of the severed piece, and hence the curve obtained by plotting the results is complete. For copper, however, the cut does not extend through the entire thickness, a sudden rupture taking place towards the close of the operation, the metal being torn apart as the tension, due to the wedging action of the tool becomes too great for the diminished section. This is true in a still higher degree in the case of iron or steel, and in all these cases the curve can only be completed by analogy, prolonging the trace to the abscissa indicated by the total thickness.

M. Codron made numerous experiments with shearing tools of various angles of acuteness, these showing, as might be expected, that the efforts increased rapidly with the increase of the angle of the tool. From these experiments he deduced general expressions from which the most efficient angle may be obtained and also by which the work required for shearing a given piece may be computed.

The action of two opposing shearing tools forms an important part of M. Codron's investigations, leading, as it does, to the consideration of machines using double rotary cutters. The use of rolling cutting tools in connection with roller chains for the purpose of cutting off pipe is also considered.

Nearly all the experiments described were performed with cold metals, but some trials were made in cutting off hot iron, and although the results were from only a few trials, it appears that the resistance of red-hot iron to shearing is between one-third to one-fourth that of the same metal when cold.

These researches upon the behaviour of materials subjected to various workshop manipulations are to be continued, and when completed, will form a valuable addition to technical information.

The Press-Forming of Materials.

A NEW method of working materials by pressure, known as the Huber system, has recently been brought out in Germany, and from a very enthusiastic account given by Professor Riedler in recent issues of the *Zeitschrift des Vereines deutscher Ingenieure,* the following abstract is given.

The earlier methods of producing designs in relief were by the use of the hand hammer, the drop hammer, or the forging or sheet metal press, dies being used, and the force of the blow or pressure taken up upon an anvil or by the framing of the machine. The objections to these methods are many. The necessity of providing the proper abutment to oppose the pressure, and the consequent danger of springing the framing of the apparatus are evident. The wear and tear upon the dies is well known, breakages being not uncommon, while the high cost of the dies, when made sufficiently substantial to resist the operations, is an important element.

The Huber process is simplicity itself, as it consists in placing both the material and the die in the interior of the cylinder of the press, so to speak, or in other words, in the inside of a vessel containing the water, the whole being thus subjected to pressure on all sides. By simply making the die of a material of somewhat greater resistance than the metal to be stamped, the latter is forced into every line and modulation of the die surface, thus producing a perfect reverse copy. Since sheet iron or sheet steel reaches the flowing point at or near a pressure of 60,000 pounds per square inch, it follows that a hydraulic pressure of about 75,000 pounds per square inch should be sufficient to obtain any effect which may be desired. Since the liquid pressure acts upon the inside as well as the outside of the object to be stamped, the method enables designs to be impressed upon the exterior of delicate hollow articles without changing the shape in the least, the dies being placed in contact with the outside surface, and a luting of cement placed around the edge to prevent the pressure from getting between the surfaces. The die need not be unusually heavy, since the pressure acts upon the back at all points, and the absolute uniformity of the liquid pressure in all directions entirely precludes any deformation of the object or of the die, the latter being simply stuck upon the surface of the article to be embossed and both immersed in the water and the pressure applied.

The packing around the edge of the die is required merely to prevent the film of liquid pressure from getting between the surfaces before the hydraulic pressure can force the metal to flow into the lines of the die, and various materials have been successfuly employed for this purpose, a sort of rubber cement having been found very suitable. Any lack of density in the packing is remedied by the effect of the pressure, and the same packing may be used indefinitely and repeatedly.

Professor Riedler shows many excellent examples of work produced by this process, the pressure in most cases being about 75,000 pounds per square inch, although pressures as high as 100,000 pounds have been successfully employed for some materials, this last being as high as has been found necessary in any case.

An important feature in connection with the process is the comparative cheapness of the dies. In the case of the older forms of presses the dies are most expensive, requiring many weeks' time of skilled die sinkers for their cutting, after which the steel must be hardened, during which latter operation many dies are injured or lost through by warping or cracking. In the new process hardened dies are not necessary, even bronze being sufficiently hard, and such dies can be made by using electrotype copies of models in some plastic material, thus permitting a wide range of designs to be used without prohibitive cost.

In some instances it is desirable to employ the process upon hot metal, in which case sand may be used instead of water for the medium for transmitting the pressure. It has been found that the addition of a zinc-iron alloy to the sand adds to its fluidity, giving it a talc-like consistency, and acting somewhat as a lubricant.

Professor Riedler naturally gives much attention to the hydraulic machinery used in connection with the process, and shows several varieties of hydraulic presses for use for various kinds of work. In view of his eminence in all that relates to the design of hydraulic machinery, his high opinion of the process and its possibilities must attract attention to it, and there is every probability that this rational method of working metals by pressure will be applied in many branches of industry.

Progress in the Utilisation of Furnace Gases.

About three years ago the well-known German metallurgist, Herr Fritz Lürmann, in a discussion before the Verein deutscher Eisenhüttenleute, took the position that blast-furnace gases could hardly be used to advantage in internal-combustion engines, chiefly because of the large proportion of dust which would prove injurious to the cylinders of the engines. At the recent meeting of the same society, held at Düsseldorf, reported in *Stahl und Eisen,* Herr Lürmann takes up the same subject and shows how the difficulties have been overcome together with the progress which has been made.

The objections which were originally made to the use of furnace gases were: (1) its variable composition; (2) the small proportion of combustible gases; (3) the presence of dust and of metallic vapors; (4) the presence of vapor of water.

Taking up these objections in order, in the light of the experience which has been had since 1898, it appears that they were partly unwarranted, and have otherwise been practically overcome. The varying composition of the gases seem to have produced little or no effect upon the action of the engines, especially when the discharge of several furnaces has been delivered into one main, and mingled before using.

The small proportion of combustible constituents in the gas, or as it is commonly termed, its leanness, has also been found no objection. The only result of the character of the gas is the necessity for a slight increase in the diameter of the cylinder of the engine. Thus one cubic metre of furnace gas, with a thermal value of 880 calories requires for its combustion 0.71 cubic metres of air, or in practice about one cubic metre is allowed; thus giving 2 cubic metres of explosive mixture, furnishing 880 calories. A cubic metre of illuminating gas, with a thermal value of about 5,225 calories, would require for its complete combustion in the cylinder of an engine, 7 cubic metres of air, giving a total of 8 cubic metres, of which 2 cubic metres would then have a value of 1,306 calories, so that for equal power the cylinder for an engine using furnace gas would have to be about 50 per cent. larger volume than if illuminating gas were used. Furnace gases often show a calorific value of 900 to 1,000 calories, and at the Mansfield Copper Works at Eisleben a Körting gas engine is operating satisfactorily with a gas containing only 700 calories per cubic metre. For use with lean gas it is desirable to have a somewhat higher degree of compression than for the richer gas, but this requires only a slight modification in the construction of the engine.

The influence of dust in the gas requires especial consideration. With regard to the nature of the dust a careful distinction must be made between the finely divided coke, iron-ore, and limestone, and the metallic portion. The metallic content may be partly in the form of particles and partly as metallic vapor, the latter being oxidised in the cylinder and there precipitated in the form of dust. Heavy particles of dust may be separated by gravity from the gas before delivery to the engine, but the very fine dust may be carried for hundreds of feet, floating in the gas, but mixing with the lubricant in the cylinder, there forming a gritty substance capable of injurious action upon the rubbing surfaces. Herr Lürmann contended, more than three years ago, that furnace gases should be passed through a wet scrubber before delivery to the cylinder, and this position is generally confirmed in practice. In fact, in his recent communication at the meeting of the Iron and Steel Institute, M. Greiner, of Seraing, admitted the desirability of scrubbing the gas. At Seraing, the gas is used successfuly just as it comes from the furnaces, but in Luxembourg, where the gas is much dirtier, wet scrubbers are satisfactorily employed.

The presence of the vapor of water in the gas appears to offer no inconvenience in practice, as the many engines in continuous service show.

In order to give an idea of the extent to which furnace gas has been introduced as a fuel for gas engines, a table is given of the product of the various firms building engines for this purpose, the record being brought down to April, 1901. The total at that date was 77,545 h. p., of which 18,000 h. p. came from the Cockerill works at Seraing, Belgium; 13,350 h. p. from the Otto works at Deutz, and 16,300 h. p. from the Deutsche Kraftgas-Gesellschaft, the builders of the Oechelhaüser engine.

It is interesting to note that in America, the country producing the greatest output of iron and steel, no engines driven by furnace gases are in practical use. In England, where the idea first originated, but few are in operation, while in France about 8,000 h. p. of small gas engines is in use. The little principality of Luxembourg, with a population of only 236,600, has large engines to the extent of nearly 10,000 h. p. installed, while in Belgium there is 7,600 h. p., and in Germany nearly 45,000 h. p.

Herr Lürmann gives descriptions of various devices in use for scrubbing and purifying the gas, including centrifugal purifiers for removing the heavier particles of dust, and washers for precipitating the finer dust. Plans of the gas-electric installation at the Gutehoffnungshütte at Oberhausen, and the gas-blowing engine plant at Differdingen are also given, and many details of the operation of these and many other large plants.

The great question, in view of the actual success of the installations in use, is one of cost. The large volume of gas delivered by blast furnaces, about 4,500 cubic metres per ton of iron, and the first cost of a plant capable of scrubbing such quantities of gas are are produced by modern large furnaces, must be considered. From data obtained from a number of large plants, it appears that the cost of installing a purifying plant ranges from 4 to 6 marks per cubic metre of gas purified per hour, and in the instances in practice this has been found satisfactory.

Herr Lürmann's paper contains much valuable information as to the present status and practice of this important industrial subject, and should go far toward furthering the extension of this method of utilising a valuable waste product.

Boilers and Engines for Superheated Steam.

With the fuller understanding of the wasteful effects of cylinder condensation in steam engines, and with the improvements in the manufacture of high-temperature cylinder oils, there has come a revival in the employment of superheated steam. It is generally admitted that superheating is at present the most effective way to diminish internal losses due to condensation in the cylinder, and in practice the results have been such as to confirm the theoretical deductions.

In a paper recently presented before the *Verein deutscher Ingenieure* at Essen, by Herr Hunger, the recent advances in the production and use of superheated steam are discussed, and some interesting practical points brought out.

The proper use of superheated steam involves consideration both of the boiler and the engine, the superheater properly being an extension of the steam generating end of the plant, while the engine should be especially designed, if the best results are to be attained. The importance of designing the whole plant with a view to the use of superheated steam has been especially emphasised by Herr Wilhelm Schmidt, who has realised some remarkable results with the engines and boilers constructed according to his plans.

In regard to the boiler, it is of much importance that ample space be provided in the flues to receive the superheater, and that an increase in chimney draft be given to offset the increased resistance to the gases in passing through the space about the superheater tubes. When proper care is not taken it is found that the boiler efficiency is reduced by the introduction of a superheater, but Herr Hunger cites a case of a boiler which was thrown out because of its poor efficiency, and which when properly reset, in connection with a superheater showed the high efficiency of 78 per cent.

The steam engine should be designed with especial reference to the use of superheated steam. It is a common error to make the cylinder too small, using the same dimensions as would be required for saturated steam. In a given engine, for the same point of cut-off, steam superheated to 300° to 350° C. gives less power than saturated steam. The pressure of superheated steam falls more rapidly during expansion than is the case with saturated steam. For these reasons it is necessary for the same power, to make the diameter of the cylinder somewhat greater for use with highly superheated steam than when saturated steam is employed. With many forms of engine it is impossible to use steam heated above 300° C., because of the effects of expansion upon the metal of the cylinder. When the ports are cast upon one side of the cylinder, the unequal expansion causes a warping and curvature which may cause the piston to bind, producing excessive friction and wear. In the case of a 1,500 h. p. engine tested by Professor Schröter, it was found impossible to start when the temperature was raised above 220° C., as the piston bound in the cylinder. For the same reason it is difficult to obtain good results with slide valves, or with cylindrical valves, and poppet valves have been found preferable. Many such points have arisen in the attempts to use highly superheated steam in practice, and hence it is important that such difficulties should be known and considered in new installations.

Herr Hunger calls attention to several points of importance in connection with the design of superheater plants, which embody the results of much experience. The best boiler for this service is the shell boiler with large steam and water space, permitting good combustion, and generous proportion of flues. The earlier superheaters consisted of arrangements of spiral tubes, connected in such a manner that the whole was disabled in case of a leak, involving the tearing out of a portion of the boiler brickwork in case of repairs. Modern practice avoids the use of right-and-left threads or other joints exposed to the action of the heat, and provides for access to all the points from the outside, without disturbing brickwork; and it should be possible to cut out any section in which a leaky tube or member may occur without disabling the entire system. With regard to the engine, the general form of the modern steam engine may be followed, but especial care should be taken that the high temperatures shall not act to curve the cylinder. The valves and stuffing boxes must be constructed to withstand the heat, and to remain both tight and free to move.

Superheaters are generally placed behind the boilers, in the flue leading to the chimney, although when the space is too contracted to permit of this arrangement, a chamber may be constructed above the boiler. Care should be taken to permit the superheater tubes to be well drained, as otherwise water is apt to collect in the lower portion, and in spite of the heat it remains difficult to dislodge, since in most instances there is no provision for water circulation. The space taken up by the water diminishes the capacity of the superheater, and the water is apt to be carried over suddenly to the engines, with disastrous results.

In designing the flues for conducting the gases to the superheater, arrangement should be made to divert a portion of the gases from the superheater by a by-pass, otherwise, when the boiler is forced, excessive superheating may result, to the injury of the engines. A rate of combustion of about 80 kilogrammes of coal per square metre of grate (about 16.5 pounds per square foot) has been found to deliver the gases to the superheater at a sufficiently high temperature to insure satisfactory superheating; the proportion varying somewhat with the character of the boiler and the nature of the fuel.

In some cases, where the boiler plant is already in use, and superheating is desired, it has been found preferable to construct a separately fired superheater. The principal objection to this apparatus lies in the fact that the gases coming directly from the fire are too hot to be permitted to come into immediate contact with the superheater, as too high a degree of superheat would be produced and the tubes would also speedily be destroyed. Such furnaces have been arranged to admit a proportion of external air to mix with the hot gases, but this is a wasteful method, and it is better to arrange a feed water heater to receive the first force of the fire, and permit the gases then to reach the superheater.

Data from a number of tests are given, showing the economy of engines working with superheated steam, the best of these being a 200 h. p. engine, tandem-compound, which with steam superheated to 346° C. required 4.87 kilogrammes steam (10.07 pounds) per indicated horse-power-hour.

Radiations from Metals.

EVER since the discovery, in 1896, by Becquerel, of the property possessed by the metal uranium of emitting rays similar to those produced by the Crookes tube, the subject has been carefully studied, especially by Mme. and M. Curie and bv M. Debierne, the results having been given to the world in successive communications to the French Academy.

In a recent issue of the *Memoirs of the Société des Ingénieurs Civils de France* an excellent review of the whole subject is given in a paper by M. Paul Besson, and the possibilities of the subject render some abstracts of his communication appropriate.

The action of these rays is most curious, since they produce electricity, excite chemical action at a distance, act upon photographic plates through opaque bodies, and, under certain conditions, are spontaneously luminous.

Such unexpected phenomena are worthy of the study of all who are interested in that applied science which constitutes the engineering of to-day, since they indicate altogether different ideas concerning the nature of things from those which we are accustomed to have. Becquerel discovered these rays to be emitted by the metal uranium, but in experimenting with pitch blende (oxide of uranium) and with chalcolyte a new element, having chemical properties similar to bismuth, was discovered, this being called "polonium." This was followed by the isolation of another element belonging to the same group as barium, and called "radium"; while, in 1899 Mr. Debierne discovered a third element, resembling thorium, and named by him "radium." Among various properties, these newly discovered metals possess what has been called "radio-activity" in a high degree. This action must not be confounded with phosphorescence or fluorescence, since it does not appear to have been obtained from any external source, such as absorption of calorific, luminiferous, ultraviolet, Röntgen, or, cathode rays. On the contrary there appears to be an undiminished emission of energy, even after all possible precautions have been taken to isolate the metal from all external radiations.

The properties of these rays have as yet been only partially investigated, they include photographic action, deviation of the magnetic field, modification of the electrical conductivity of air, discharging action upon electrified bodies, but they are not capable of reflection, refraction or polarisation. M. Besson examines at length the results of the various investigations of Mme. and M. Curie, and to his paper reference must be made for a more detailed account.

To the engineer the principal features of interest which these phenomena present are those which bear upon his pre-conceived notions of the ultimate constitution of matter. We find ourselves possessed of certain bodies which are spontaneously luminous, producing electricity, acting upon photographic plates, coloring glass, and at the same time sustaining no appreciable change. These substances produce energy without apparently receiving it from any external source. They appear to contain within themselves an indefinite supply of power. These are facts which overturn all our ideas of mechanics, physics, and chemistry.

In whatever way we endeavor to explain the phenomena we find ourselves in a new field, calling upon us to modify our previous views of matter and energy. Matter, heretofore considered as in itself inert, is seen to be filled with activity sending emanations of all kinds forth into space some luminous, others atomic, combining, reacting, modifying living matter, producing sensations, and for all we know, inspirations. Psychical phenomena may be found to consist of effects wholly dynamical, but as ever before, due to an unknown cause, a cause which recedes constantly as we approach, and which seems more and more remote as we discover effects, which, while new to us, have been existing continuously in the past as we find them in the present.

Underground Transport in London and Paris.

In view of the strikingly similar conditions existing between the completed portion of the Paris Metropolitan and the London "twopenny-tube" it is of interest to compare the results of their operation. Each line follows the diameter of a great capital, the lengths being practically the same, 6½ miles, the traction systems similar, and the date of opening differing by less than two weeks, the Paris road being open on July 19 and the London one on July 30, 1900, and both being in full effective operation on August 12, of the same year.

According to the published reports, the London road at first surpassed in daily passenger traffic, the figures being about 80,000 for London, and 45,000 for Paris. As might be expected in time of an exposition, however, Paris soon passed London, and by October the figures stood at 85,000 for London and 105,000 for Paris. The London traffic, however, continued to grow, and during December it reached a daily total of about 100,000. In Paris the traffic did not fall off at the close of the exposition, but continued to grow, passing 130,000 per day, at the close of December.

The mean daily totals of passengers from the beginning of August to the close of December, 1900, were for London, 92,910, and for Paris, 103,930, while taking the months since the close of the exposition, the corresponding averages were 97,440 for London, and 115,232 for Paris. In round numbers it is estimated that there will be 40,000,000 passengers per year in Paris, and 33,000,000 in London.

In spite of the difference in passenger totals, the receipts of the London road have been greater than in Paris. In London, the daily receipts have averaged £804, or about 20,270 francs, while the daily receipts of the Paris Metropolitan have averaged, since the exposition, 19,614 francs. This difference may be due to the fact that the price in London is twopence (0.21 franc) for all distances, while in Paris it varies from 0.10 to 0.25 franc, according to the class.

REVIEW OF THE AMERICAN PRESS

The Testing of Steam Engines.

THE committee appointed by the American Society of Mechanical Engineers to codify and standardize the methods of making steam engine tests has made a preliminary report, which, while presented for the purpose of eliciting discussion and amendment, yet doubtless contains the general principles which will remain as the foundation of the final report.

Starting with definitions, it is plainly declared that the object of an engine test is broadly the determination of the economy with which the engine produces a given amount of power; this involving two elementary quantities, the amount of steam, fuel, or heat consumed, and the amount of power developed.

As it is the engine alone which is the subject of test, it is important to eliminate boilers, furnaces, or fuels, as elements, since these include variations which would render the results non-comparable. The only unvarying unit expressive of energy consumed is the heat unit, and it is therefore a foregone conclusion that the standard of consumption for all heat engines should be referred to heat units. The measure of power delivered is left as the old term horse-power, this being so generally understood as to need only the division into indicated and brake horse-power, to be altogether satisfactory.

The committee says:

"The expressions of engine efficiency which meet both the requirements noted, are the number of heat units consumed per hour, both per indicated horse-power and per brake horse-power, and these we recommend as the desired standards of comparison. The heat unit standard does not interfere in any sense with the common terms of expressing efficiency of engines. The hourly weights of coal, gas, or other fuel, or weight of steam, consumed per horse-power, heretofore commonly employed, are additional forms of stating the efficiency, and are none the less useful within their limitations. They should by no means be abandoned. Neither should the standard forms recommended for expressing the duty of pumping engines, or the efficiency of locomotives, previously accepted by the society, be changed. There is no conflict here with the proposed new standard. In the scheme presented by your committee these various additional or subsidiary forms of stating efficiency, as applied to particular classes of engines or kinds of service, are suitably provided for.

"The heat consumption of a steam engine for the standard test is ascertained by measuring the quantity of steam consumed, calculating the total heat of evaporation of the entire quantity, and crediting this total with that portion of the heat rejected by the engine, which is utilized and returned to the boiler. The term 'engine' as here used should include the entire equipment which is concerned in the production of the power, embracing the main cylinder or cylinders the jackets and reheaters, the air, circulating, and boiler feed pumps, if steam-driven, and any other steam-driven mechanism necessary to the working of the engine. We believe that the heat unit standard makes it both desirable and obligatory to thus charge the engine with the steam used by necessary auxiliaries, for the reason that it is itself finally benefited by the heat which they return, it being generally agreed that exhaust steam from such auxiliaries should be passed through a feed water heater, and the heat thereby carried back to the boiler.

"The heat consumption of gas, oil, or other engines of the internal combustion class, is found by ascertaining the total heat of combustion of the particular fuel used, which should be determined by a calorimeter test, and multiplying the result by the quantity of fuel consumed.

"The indicated horse-power for the proposed standard is that determined by the use of steam engine indicators. It should be confined to the power developed in the main cylinder or cylinders, and should not include that developed in the cylinders of auxiliaries."

The main difference between the preliminary report and that of the "Thermal Efficiency" committee of the Institution of Civil Engineers appears to be in the inclusion of steam-driven auxiliaries in the American code as chargeable to the engine, but since the test is primarily a commercial matter it appears reasonable that the consumption of the auxiliaries should be included, although it is most desirable that they should be in such form as to be capable of independent investigation.

The code appears to be most complete in all its provisions, but its examination had best be deferred until it shall have passed the ordeal of criticism for which it was put forth, and with this end in view all who are interested in engine tests should procure and examine it.

Transportation Across the Hudson at New York.

For a long time the question of a bridge across the Hudson river at New York, to enable the important railways converging on the opposite shore of New Jersey to enter the metropolis, has been discussed, and hence the paper of Mr. C. W. Buchholz, recently presented before the New York Railroad Club, treating of the general problem of all-rail transportation across the Hudson river at New York City, is to be welcomed, treating as it does of the general considerations which enter into the subject.

In order to form a clear opinion upon the practicability of bringing the railway communication across the river, or indeed, as to the desirability of doing so at all, it is necessary to consider the present conditions of transport to and within New York. Briefly the problem is that of bringing into New York, in train loads, all the immense traffic which is poured daily into Jersey City and its adjacent towns by three trunk lines and by three railways of nearly equal importance. This freight, exclusive of coal and grain amounts to about 30,000 tons, or 2,000 car loads per day.

"The impossibility of accomplishing this proposition will be apparent to everybody when it is considered that these railway companies occupy now, with their docks, piers, stations and warehouses, more than four miles of the Hudson River front on the Jersey side opposite the city of New York, and that every one of these six railway companies has covered many hundred acres of land with its tracks for miles back from the harbor for the purpose of having adequate terminal facilities to transact the constantly increasing business with New York. To transfer all this business to one or more freight stations in this city, or only so much of it as must find its way rapidly for immediate consumption or storage to warehouses and stores without counting what goes directly for re-shipment to vessels, and to do such business with dispatch, would require an area equal to that enclosed between the two rivers and between 14th and 23d Sts., and would necessitate a network of track from one end of the city to the other, either above or below the streets."

Apart from the physical difficulties connected with the problem there must be considered the desirability of accomplishing it.

"Manhattan Island, with its great city, is phenomenally fortunate in its situation, although cut off by water from the rest of the continent. Its narrowness and its length, accessible everywhere to deep-draft vessels, to floats and to barges, enables the transportation companies cheaply and quickly to deliver freights and goods always at the nearest point to the warehouse or store of the merchant. Very little hauling by teams would be necessary if the city of New York would improve its river front and set apart for the use of railway companies, at certain fixed distances around its whole circumference, the necessary piers and docks to be operated by one general terminal company, whose duty it would be to receive and deliver freights to any of these points and at any of the railway depots in Jersey City."

At the present time every one who is at all familiar with New York realizes the difficulties which are daily encountered in the transport of such traffic as is absolutely compelled to traverse the length of the island. During the rush hours of the morning and afternoon the congestion upon the few possible longitudinal lines of transport, whether steam or electric, elevated or surface, is daily becoming greater, while with this is mingled the most obstructive of all kinds of traffic, that of the horse-drawn truck. To add to all this the distribution of the great mass of merchandise which a bridge would concentrate at one point, would be to take from New York the use of one of its greatest advantages for distribution of merchandise, the river. To substitute for this great diverging outlet a converging one, bottling up the traffic, instead of distributing it along one of the finest water fronts in the world, hardly seems conceivable.

For passenger traffic, there is something to be said for the idea of a bridge, but even in such case the advantages are contingent upon certain modifications in the existing order of things. It is the coming traffic which must be considered, rather than the present, and this depends not only upon the increase in volume, but also upon possible changes in direction and distribution, changes which the nature and location of the bridge itself might do much to determine.

"In round numbers about 100,000,000 people cross and re-cross the Hudson River every year, of which amount about 40% arrive by trains at the various termini of the railroads. There are now five such passenger stations at Jersey City, Hoboken and Weehawken, belonging to the Central Railroad of New Jersey, the Pennsylvania R. R., the Erie R. R., the Delaware, Lackawanna & Western R. R. and the West Shore R. R., where all passengers destined to or coming from New York, suburban as well as distant, are delivered, together with those coming from branches and connecting lines that have no termini of their own. The total number of passenger trains daily arriving and departing from these stations is about 1,080; those trains reach and leave there on ten main tracks and are distributed at the stations upon 48 tracks provided with a corresponding number of platforms. These figures give an approximate idea of what will be necessary to transport this traffic across the river and what will be necessary to accommodate and handle it with dispatch at the terminus in New York."

It cannot be expected that the construction of a bridge as far up as 23rd St. would induce even a major portion of the present traffic to abandon the ferries. The downtown district must ever remain the financial and office business section of New York, just as the City maintains its similar position in London. At the same time it must be evident that a great portion of the general and retail business of New York is moving northward, both occupying locations readily accessible from such a bridge terminal, and at the same time diminishing the available residence area on Manhattan Island. The mass of people engaged in business in this great central area will be largely compelled to reside across the river and in the suburban tributary towns of northern New Jersey, and the construction of a bridge would have a profound influence both on the location of the newer business district of New York and the extension of suburban residence sections tributary to it. From this point of view the advantage would be as great, if not greater to New Jersey than to New York, and if a bridge is to be constructed and used it must be with the co-operation and aid of New Jersey.

"But without the assistance of the various cities and towns on the Jersey side of the river, and without the active co-operation of the city of New York by direct contribution, or by municipal grants, it will be almost impossible to execute and to operate successfully so stupendous an improvement, and especially so from a legal point of view. If New York city would cast aside its fear that a bridge across the Hudson river would drive half its population into New Jersey, or at least retard its own growth northward, for which purpose the city is now spending so much money; if New York would grow to the full height of its destiny and look upon the cities opposite the river in New Jersey as she does upon Brooklyn, as being a part of herself, perhaps we then might all live long enough to point with pride to a structure, magnificent in its lines and proportions, spanning one of the grandest rivers in the world and unsurpassed in history as a work of engineering skill and of civic enterprise."

The Study of Hydraulics.

THERE are probably few subjects about which so much has been written and so many theories advanced as the apparently simple matter of the flow of water in a given channel, and yet there are few about which so little positive knowledge has been obtained. The accepted formulas are for the most part empirical, and can be safely applied only to channels closely resembling those from which the experimental data have been obtained, and unless those conditions are known serious errors are apt to occur.

In a paper presented to the Detroit Engineering Society by Mr. George H. Fenkell, and published in the *Journal of the Association of Engineering Societies,* there is given a general study of the various formulas, comparing their origin, character, and applicability, and this paper, together with the appended discussion by several well-known engineers, is a welcome contribution to the subject.

In beginning, Mr. Fenkell says: "The student in hydraulics at first is often led to believe that the formulas for the flow of water through channels of different kinds, through orifices and over weirs, are derived from certain well-known laws, such as those of gravity and friction, whose character and nature have been so thoroughly studied that they admit of little or no variation. His belief in that line is strengthened when he finds how long many of these formulas have been in general use and the number of years they have appeared in precisely the same form in text books and manuals.

"If the subject is pursued farther, however, it will be observed that all have been founded upon, or at least verified by experiments made at different times, by different persons and under various conditions. Many have evolved formulas from their own results and perhaps a limited number of others that agree with their own fairly well, disregarding those made under as favorable conditions, but which do not seem to follow the same laws.

"A large number of formulas have been derived to determine the friction in closed pipes or conduits running full, under pressure, such as cast iron, wrought iron, steel, and wood; and so often, in fact, has this ground been beaten over, that many, after various attempts to find rules that will fit all cases, have given up in despair."

In order to obtain some sort of comparison between such conflicting methods, Mr. Fenkell has undertaken the most laudable task of weighing and plotting a great number of observations and formulas, with the purpose of determining the value of the constant c in the Chezy formula: $v = c \sqrt{rs}$ and the paper is mainly composed of the collection and arranging of the data. These data are chosen altogether for pipes, and the relation between friction head and velocity head naturally enter largely into the question. The friction head being taken as equal to the velocity head multiplied by a constant, plus a constant, can be plotted as a straight line, and Mr. Fenkell thus determines it from a large number of experimental data.

The Chezy formula, it is shown, may be modified so as to permit different exponents for "r" and "s," and taking the exponent of "s" as equal to 0.5, it appears that a somewhat larger value for the exponent of "r" renders it possible to consider the coefficient "c" as practically constant.

In discussing Mr. Fenkell's paper, Mr. Allen Hazen calls especial attention to the extent to which the coefficient "c," assumed by Kutter and other noted investigators to be necessarily variable, may be made practically constant for any given material and surface by choosing the proper exponent for "r." Writing the Chezy formula as: $V = CR^x S^y$, originally suggested by Tutton, and making the exponent $y = 0.50$, it appears that "x" should be somewhere between 0.50 and 0.75, the latter value having been proposed by Sullivan in his "New Hydraulics." Mr. Hazen, from a graphical comparison of plotted data, drawn upon logarithmic paper, finds that if "x" is made equal to 0.625, C will remain practically constant for a given character of surface, thus greatly simplifying the determination of the discharge of pipes, and by using the slide rule for the computations the labor of calculation may be greatly diminished.

The discussion upon Mr. Fenkell's paper contains much interesting matter contributed by a number of experts in the study of hydraulics, and among the features included may be mentioned some data contributed by Mr. John C. Trautwine, 3rd, upon the resistance offered by water meters to the flow of water through them, a field of investigation until now little cultivated.

The great obstacle in the matter of the measurement of the flow of water appears to be the difficulty of determining a most important element in the resistance. It is too common to assume that the resistance in a channel is mainly due directly to the friction of the water upon the wetted perimeter, and, in formulas of the Chezy type, the quantity "R," the hydraulic radius, as it has been called, is intended to bring into the computation the frictional resistance of the surfaces of the channel or pipe. As a matter of fact, much of the resistance is due to what Professor Johnson has called "the internal work of the water," being the swirls and eddies in the body of the stream, undoubtedly indirectly due to the character of the surface of the channel, but not altogether analagous to ordinary frictional resistance. The effect of this internal work is well shown in the resistance produced by changes in the diameter of a smooth surfaced channel, an enlargement and contraction to the original dimensions producing eddies which absorb energy and create resistance, but which cannot be measured or formulated in any practical manner. It is doubtless due to such resistances, varying as they do in nearly all experimental tests, that many conflicting results are due, and until some method is found of including such disturbances in the observed data, the construction of a satisfactory formula, with constant coefficients and exponents can hardly be expected.

The New Edison Storage Battery.

EVER since the practical development of the lead plate accumulator it has been found to be possessed of two important and opposing properties, one, great usefulness as a means of enabling energy to be carried from place to place, and utilized while in transit, the other, excessive weight, seriously interfering with its use in motor vehicles and similar constructions in which portability is essential. It is not surprising therefore, that, along with the efforts which have been made to increase the efficiency and life of the storage battery, the question of reduction in weight has been considered one of prime importance. These considerations give especial interest to the paper of Dr. A. E. Kennelly, recently presented before the American Institute of Electrical Engineers, describing the new form of storage battery of Mr. Edison.

Referring first to the present forms of lead battery, in which lead peroxide is the depolarizing substance, it is found that in general practice the storage energy per unit mass is from four to six watt hours per pound of battery. That is to say, a battery weighs from 125 to 186 pounds per horsepower hour at its terminals; or, if its stored energy available at terminals were all expended in gravitational work, a battery could raise its own weight through a vertical distance of between two and three miles. These figures represent the average practice, although it was stated at the meeting that efficiencies of practically double this had been obtained in certain cases. Certain, it is, however, that the weight of the lead storage battery has been the greatest impediment to its more extensive introduction.

"While it is possible to increase the energy per unit mass by making the electrodes very light, yet this is always found to be followed by a very heavy deterioration.

"Many attempts have also been made to perfect storage cells of the alkaline-zincate type, but the great difficulty of depositing zinc in coherent form from the solution, as well as the lack of a depolarizer that shall be insoluble in the electrolyte, has stood in the way of this cell's success.

"Mr. Edison set himself the task of finding a cell which should possess the following advantages:

"1. Absence of deterioration by work.

"2. Large storage capacity per unit of mass.

"3. Capability of being rapidly charged and discharged.

"4. Capability of withstanding careless treatment.

"5. Inexpensiveness.

"He believes that the cell here shown may claim these advantages in a very satisfactory degree.

"The negative pole or positive element, corresponding to the zinc of a primary cell or the spongy lead of a secondary cell, is iron. The positive pole or negative element, corresponding to the carbon of a primary cell or lead peroxide of a secondary cell, is a superoxide of nickel believed to have the formula NiO_2. The cell is therefore a nickel-iron cell, a name which suggests the structural material—nickel-steel.. The electrolyte is potash; *viz.*, an aqueous solution containing from 10 to 40 per cent.

by weight, but preferably 20 per cent. of potassium hydroxide, the freezing temperature of which is 20 degrees below zero Fahrenheit or—30 degrees centigrade."

Comparing this cell with the lead battery, it appears that the storage capacity per unit of mass is 14 watt-hours per pound, as against six for the old type.

"Expressing the same statement in another way, the weight of battery per unit of electric energy at terminals is 53.3 pounds per electrical horse-power-hour or 32.4 kilos per kilowatt-hour. Or the battery gives energy at its terminals sufficient to lift its own weight through a vertical distance of approximately 7 miles or 11.26 kilometres. The mean normal discharging power-rate per unit mass of total cell is 4 watts per pound or 8.82 watts per kilo. Corresponding to a normal discharge period of three and one-half hours. The cell may, however, be discharged at a relatively high rate, in approximately one hour. Corresponding to a discharging power-rate per unit of total cell mass of 12 watts per pound or 26.46 watts per kilo. Charging and discharging rates are alike. That is to say, the cell may be charged at the normal rate in three and one-half hours; or, it may be charged at a relatively high rate in one hour, with no apparent detriment beyond a somewhat lowered electrical charge efficiency. In other words, the cell does not appear to be injured by over-charging or discharging, and only suffers in electrical efficiency under such treatment."

Physically speaking, the call may be termed an oxygen lift. Charging pulls the oxygen away from the iron and delivers it temporarily to the nickel. The condition is then stable, until the circuit of the cell is completed. Discharge then allows the oxygen to fall back from the nickel to the iron with the natural affinity of iron and oxygen. The potash solution suffers no change, but acts merely as a carrier of the oxygen, while in the case of the lead peroxide cell the solution becomes gradually changed from dilute sulphuric acid to plain water. There is, therefore, in the new cell opportunity to reduce the weight by diminishing the quantity of solution in addition to the much less weight of plates required.

Details of the mechanical structure of the cell and diagrams of its performance were given, and there is no doubt that Mr. Edison has accomplished all that he set out to perform in the five points stated above.

One immediate feature which should appear with its introduction should be a marked increase in the use of electrically propelled vehicles, since with the lighter battery the radius of action will be practically doubled for the same weight, or for moderate runs much lighter vehicles will become practicable.

Electricity in Mountain Mines.

A RECENT paper read before the American Institute of Electrical Engineers by Mr. F. W. Brady upon the subject of electric machinery in difficult mining countries contains much matter which should be read and appreciated by manufacturers who hope to participate in the valuable and important business of supplying such apparatus.

In the first place it should be fully understood that such material must be capable of separation into sections small enough to be carried over burro trails several miles in length and often of more than ordinary difficulty. An example of misplaced labor is given in the case of a cast iron drum of 4½ by 5 feet, weighing 3,500 pounds being transported by rail for more than 1,000 miles, only to find a permanent resting place within a few miles of the mine where it was intended to have been used.

Another point demanding more careful attention than is generally given is the amount of power available. Water power is generally over-estimated, and care should be taken to get reliable data, extending over as many teays as possible, or the variable character of mountain streams may prove most deceptive. The report of the constructing engineer should be very complete, not only regarding the water power, but also concerning the conditions in the mine, the possible methods of transportation, special requirements in design of apparatus, maximum weight and dimensions of parts, topography of the district for pipe lines, etc., etc.

It must not be forgotten that air compressers operated in high altitudes lose a portion of their capacity, owing to the rarefied condition of the atmosphere, while electrical apparatus suffers from lightning. Electrical storms are of frequent occurrence in the mountains, and heavy discharges sometimes occur from the lines in clear weather, so that especial attention should be paid to lightning arresters.

Mr. Brady gives a detailed account of the equipment of the American Nettie Gold Mine, at Ouray, Colorado, this being a good example of an installation in which all the mine machinery and most of the materials for the transmission line were transported from the railway over a burro trail. In this interesting description will be found examples of the difficulties which have to be overcome, and a study of this and other similar installations should form excellent preliminary training for those designing not only electrical, but also general machinery for use in places where, notwithstanding the difficulties of transport and operation, power and transmission plants are most valuable investments.

The Multiple-Unit Tramway System.

In a recent issue of the *Street Railway Journal* there appears a paper by Mr. Frank J. Sprague, giving a general account of the multiple-unit system for operating trains of electric cars, and in connection with it is also given an article by Mr. George H. Hill containing some interesting notes on the history and development of the system.

In view of the importance of the subject and its possible bearing upon the wider one of the use of electric driving on main-line railways, some abstract of these papers is here given, and the interested reader is referred to the originals for further details.

The use of electricity for tramway traction naturally was at first limited to single cars, and even at the present time, one motor car and one trailer is about all that is considered advisable to employ on surface roads in city streets. With the extension of electric traction to elevated railways, however, the control of the right of way, and the absence of grade crossings permitted the use of trains of several cars, and as such roads were originally usually operated by steam locomotives the practice has more or less become assimilated to that of main steam railways.

While the train is a necessity of the use of the travelling power house known as the locomotive, the different conditions under which electric traction is operated make other arrangements possible, since the mechanism for the application of the motive power is the only portion carried upon the cars, and the power generation is conducted at one or more stationary power houses at convenient locations.

At the same time the construction and operation of steam roads according to the train system, and the development of such transportation business entirely on the train basis has made it practically necessary for electric traction, from a commercial standpoint, to be operated upon the principle of trains, if it is to supersede steam, and to meet this idea Mr. Sprague developed the "multiple unit" system which he has recently put into successful operation on the South Side Elevated Road in Chicago.

It is important that a distinction should be made between distributed motor control and multiple-unit operation. The terms are not synonymous, nor need they be operated by similar methods. The former may represent simply the physical shifting in location of a part of the motors constituting a train equipment. The latter is a generic method of train make-up and operation in which power-controlled units capable of independent operation can be aggregated into a train, with or without other units partially equipped, and all the units be simultaneously controlled and operated from one or more of them.

The details of the Sprague system cannot be discussed without numerous diagrams of the apparatus and connections, and such are very fully given in Mr. Sprague's paper, referred to above. It must here suffice to say that it consists of two main motors on each fully-equipped car, with three principal switches for determining the connections and the flow of current. There is a reverser, for changing the armature connections of the two motors, a rheostat for varying the resistance in the circuit with them, and a motor switch for effecting the series in parallel relation.

These main switches are primarily controlled from a masters' switch on each platform of any equipped car, through a train line and suitable relays and a pilot motor. Such completely equipped cars can be connected together to form trains, with or without train line cars, these latter having only train-cable couplers and jumpers, unless it is desired to control an equipment from them, in which case master switches can be added.

The platform switch circuits, the local operating or relay circuits, and the train-line circuits are joined together by switches which permit such independent connection on each car that controllers on any car can be operated from the master switch on its car no matter how a train is made up, without the controllers on other cars being affected, or the controllers on as many cars can be operated from the master switch on another car without the controller on that car being operated, as well as the normal operation of all controllers from any master switch.

The success which has attended the operation of the multiple control system in Chicago, and the adoption of the system upon the Manhattan Elevated Railroad in New York is sufficient evidence of the practicability of the system, and the operation of these roads is sufficiently similar to that of the ordinary steam railways, that this may rightly be termed the entering wedge in the introduction of electric driving on steam railways.

Mercury Vapor Lamps.

At a recent conversation held by the American Institute of Electrical Engineers, Mr. Peter Cooper Hewitt made a most interesting exhibit of mercury vapor lamps. and from a subsequent communication published in the *Electrical World and Engineer* gave some notes upon the subject.

The lamps shown by Mr. Hewitt consisted of glass tubes of two to five feet long and ¾ to 1½ inch in diameter, containing vapor of mercury, and fitted with terminals at each end for connection to the electric circuit. These tubes, upon the passage of an electric current, emitted a brilliant light, ranging from 500 to 1,000 candle power producing a most effective display.

While there is some resemblance in construction between these mercury lamps and the well-known Geissler tubes, there are also important differences. The Geissler tube contains a rarefied gas, and is traversed by an alternating high-tension current from an induction coil, the light varying in color according to the gas and being usually stratified and rather feeble in illuminating power.

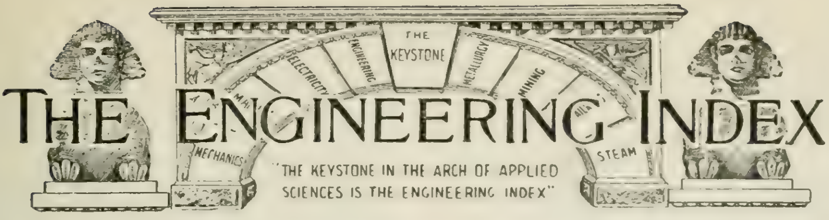
The mercury lamp, on the contrary, employs a low voltage continuous current, and instead of showing a feeble light the interior of the tube is filled with incandescence.

Mr. Cooper's exhibit was intended to show several facts connected with this form of light, especially its high efficiency and to illustrate the laws of conduction of the electric current by gases and vapors. For this purpose the lamps exhibited were shown in connection with standard Weston voltmeters and ammeters and from the readings of these instruments curves have been plotted showing the performances.

In regard to the relation of the voltage to the gas-carrying current, it appears that the volts vary directly as the length and inversely as the diameter of the tube, this not being exactly borne out by the experiments, but with variations probably due to explainable causes. The relation of current to resistance was also investigated, and the result showed that the voltage tending to remain constant the resistance varied inversely with the current.

The efficiencies of the lamps are given for the different sizes exhibited, the results being tabulated and plotted in the form of curves. For the large lamp, with tube 54 inches long and 1 inch in diameter the candle-power ranged from 840 to 1050, with a corresponding efficiency of 0.43 to 0.65 watts per candle. The next size, 32 inches long by ¾ inch diameter, showed a somewhat lower efficiency, requiring 0.78 watts per candle at 630 candles.

That such high efficiencies can be obtained by use of direct currents as are ordinarily available, in lamps having intensities as high as 500 to 1,000 candle power is noteworthy. Such lights would be closely comparable with arc lamps for practical lighting purposes, were it not for the fact that the color is so far objectionable. The light of the mercury vapor appears to be almost entirely deficient in red rays, the small portion of red which can be detected by the spectroscope being insufficient to give a satisfactory illumination when screens are used. It has been suggested that the use of vapor of other metals in connection with that of mercury may so modify the color of the light as to enable this difficulty to be overcome, in which case the incandescent tube may take an important place in commercial lighting.



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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Drawbridge.

Replacing a Passaic River Drawbridge. Describes the method of floating away a 220½-ft. swing span and replacing it by a heavier span also floated into place. 700 w. Eng Rec—May 25, 1901. No. 41215.

Early Bridge.

The First Iron Railway Bridge. An illustrated account of a bridge built in 1823 for the Stockton and Darlington Railway. 700 w. Engr, Lond—May 10, 1901. No. 41038 A.

East River.

The Suspended Span of the New East River Bridge, New York. Illustrated description of the stiffening trusses of this bridge and the unique details of their support at the towers. 1600 w. Eng Rec—May 4, 1901. No. 40722.

Erection.

Construction Methods in Civil Engineering. Frank W. Skinner. Read before the Applied Science Soc. of McGill Univ. Introductory remarks on the technical training given civil engineers, with illustrations of typical methods of bridge erection. 6400 w. Can Engr—May, 1901. No. 40911.

Highway Bridge.

Highway Bridge of 406-Ft. Span; Hamilton, O. Illustrated detailed description of the bridge known as the Columbia bridge, across the Miami River, notable not only for its length, but also in many points of its construction. 2000 w. Eng News—May 23, 1901. No. 41201.

Hudson River.

The Problem of All-Rail Transportation Across the Hudson River at N. Y. City. C. W. Buchholz. Abstract of a paper read before the N. Y. R. R. Club, with editorial, and discussion. On the need and the problems connected with North River bridges and tunnels. 7900 w. Eng News—May 16, 1901. No. 40948.

The Problem of Providing an All-Rail Connection, across the Hudson River, between the City of New York and the Railroads Terminating on the Jersey Shore. C. W. Buchholz. A consideration of the various plans suggested, with general discussion. 8800 w. N. Y. R R Club—April 18, 1901. No. 40970.

Which Is the Best Site for a Hudson River Bridge at New York? A discussion of the conditions and locations, favoring the Fifty-ninth street site. 1800 w. R R Gaz—May 17, 1901. No. 40952.

Kinzua Viaduct.

The Kinzua Viaduct of the Erie Railroad Company. Continued discussion of paper by C. R. Grimm. 4400 w. Pro Am Soc of Civ Engrs—May, 1901. No. 41-269 E.

Military Bridges.

Military Bridges. Illustrates and describes methods of construction. 1900 w. Sci Am Sup—May 4, 1901. No. 40747.

Piers.

Piers of Midland Railway Bridge, Shubenacadie River, South Maitland, Nova Scotia. George E. Thomas. Illustrated description of the difficulties encountered and overcome in the building of these pneumatic piers. 6000 w. Jour W Soc of Engrs—April, 1901. No. 40982 D.

Reconstruction.

The Redheugh Bridge. Illustrated description of the recent reconstruction of this bridge between Newcastle and Gateshead. 800 w. Engng—May 10, 1901. No. 41044 A.

The Substructure of Glasgow Bridge Over the Missouri River. H. P. Boardman. An illustrated description of the reconstruction of this bridge, with an interesting discussion, in which Gen. W. Sooy Smith reviews the history of the old bridge, which was the first great steel bridge ever built. 12000 w. Jour W Soc of Engrs—April, 1901. No. 40979 D.

Rhine.

The New Bridge Across the Rhine at Worms (Nouveau Pont sur le Rhin à Worms). M. Seurat. With full details and views of the structure. There is one span of 388 ft. and two 351 ft., with braced bow-string girders. 2000 w. 1 plate. Génie Civil—May 11, 1901. No. 41106 D.

Swing Bridge.

Turntable and Operating Mechanism of a 360-Foot Swing Bridge. Illustrated description of a single-track swing span having a number of special features in the turntable and latching apparatus. 1200 w. Eng Rec—May 18, 1901. No. 40963.

CONSTRUCTION.

Australia.

Public Works in Australia (Les Grands Travaux Publics en Australie). A. Mahoudeau. With especial reference to Western Australia, including the harbour of Fremantle and the works in connection with the mines of Kalgoorlie. 2500 w. Revue Technique—April 10, 1901. No. 41111 D.

Brickwork.

Architectural Brickwork From the Standpoint of a Constructing Engineer. John Stephen Sewell. Discusses the necessary features of good brick work, the heads of the bricks, the joints, including the mortar, and the bond. 7000 w. Arch Rev—May, 1901. No. 41200 D.

Building Construction.

Progress of Work at the United States Naval Academy. J. P. Carlin. Illustrated description of the new Naval Academy buildings at Annapolis and the methods of constructing them; the notes on the carrying power of piles, methods of handling heavy masonry, and the construction of concrete sea walls are especially full. 4000 w. Eng Rec—May 11, 1901. No. 40872.

The Montgomery Ward & Company Building, Chicago. Illustrated description of a 12-story steel-cage office building with a tower 390 ft. high. The structural details of the latter, the special system of fire-proofing and an unusual system of open elevator shafts are described. 2200 w. Eng Rec—May 25, 1901. No. 41212.

Concrete Masonry.

Construction of Concrete Masonry of a Canal Dock on the Eastern Section of the Illinois & Mississippi Canal. Jas. C. Long. Illustrates and describes the construction work, materials used, tests, etc. Also discussion. 5000 w. Jour W Soc of Engrs—April, 1901. No. 40980 D.

Dry-Dock.

A 10,000-Ton Balanced Sectional Dry-Dock. William T. Donnelly. Reviews the past history of the docking of vessels, and gives an illustrated detailed description of the largest timber floating dry-dock that has ever been constructed. 5500 w. Eng News—May 2, 1901. No. 40737.

Exposition.

Notes on the Paris Exposition, 1900 (Einiges von der Pariser Austellung, 1900). A. Weber. With especial reference to the building construction of various nations. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—April 26, 1901. No. 41136 B.

Piers.

See Civil Engineering, Bridges.

Steel-Work.

Constructional Steel-Work as Applied to Building. Archibald D. Dawnay. Read before the Brit. Soc. of Archts. Historical review, with some discussion of constructive questions. 9600 w. Builder—April 20, 1901. No. 40633 A.

Struts.

The Strength of Struts. R. H. Smith. A review of a paper on the "Practical Column" by J. M. Moncrieff in the March, 1900, number of the Pro. of the Am. Soc. Civ. Engrs. 2500 w. Engr, Lond—April 19, 1901. Serial. 1st part. No. 40649 A.

Tunnel.

The Proposed Irish Channel Tunnel. An account of a project to connect England and Ireland by tunnel under the Irish Channel. 3300 w. Eng News—May 23, 1901. No. 41203.

CANALS, RIVERS AND HARBORS.

Australia.

See Civil Engineering, Construction.

Breakwater.

The New Stone Breakwater at Buffalo, N. Y. Illustrates and describes a new form of breakwater now under construction, built of stone, with a gravel hearting; also the methods of working, machinery used, the material, etc. 6000 w. Eng News—May 16, 1901. No. 40944.

Bremerhaven.

The Extension Works at the Port of Bremerhaven (Les Travaux d'Extension du Port de Bremerhaven). A. Boudon. An illustrated account of the new docks and power station at this important German port on the Weser. 2500 w. 1 plate. Génie Civil—April 20, 1901. No. 41100 D.

Canal Problems.

American Canal Problems, with Special Reference to the State of New York. Robert E. Horton. Considers a waterway to the Great Lakes a national question, rather than sectional. The problem of connecting the Atlantic and Pacific is regarded as of first importance, and the Great Lake outlet of second. The possible solutions of the latter are discussed. 3800 w. Marine Engng—May, 1901. No. 40763 C.

Chicago.

Schemes Suggested by the Expert Commission for the Improvement of the Chicago River. An explanation of the three schemes, with estimates. 2000 w. Eng News—May 2, 1901. No. 40741.

Currents.

The Currents in the Gulf of St. Lawrence. Summary from a recently issued pamphlet, giving an explanation of the hydrography of the gulf. 2400 w. Nature—April 18, 1901. No. 40628 A.

Dam Failure.

The Washout of a Dam at Middlefield, Mass. M. J. Gibbons. Illustrated description of a heavy earth and masonry dam destroyed by a flood over its crest, which occurred through inability to operate waste gates. 1000 w. Eng Rec—May 4, 1901. No. 40726.

Delaware.

The Shoaling of the Delaware. Plan to keep the channel deep enough to maintain navigation between Philadelphia and the sea. 1100 w. Naut Gaz—May 23, 1901. No. 41220.

Dredgers.

Smit and Sons' Dredgers. Illustrated description of a dredge, and its operation, in use in connection with the Dublin Harbor improvements. 1300 w. Engng—May 3, 1901. No. 40846 A.

Exposition.

Hydraulic Engineering at the Paris Exposition (Der Wasserbau auf der Pariser Weltausstellung). M. Paul. A review of the exhibits relating to canals, river regulation, and similar work, arranged by nationalities. Serial, Part I. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—April 19, 1901. No. 41135 B.

Isthmian Canal.

The Isthmian Canals. Extracts from the lectures of Mr. Bunau-Varilla, discussing various elements which must be considered in deciding on the relative merits of the Nicaragua and Panama routes. 2300 w. R R Gaz—May 24, 1901. No. 41230.

Mississippi.

Are Flood Heights Increasing in the Lower Mississippi River? W. J. Hardee. Condensed from a paper read before the Louisiana Engng. Soc. in discussion of the paper by L. W. Brown, in disproof of the conclusions reached. 6200 w. Eng News—May 23, 1901. No. 41206.

A Topographical Survey of the Reservoir System at the Headwaters of the Mississippi River. W. C. Lemen. Gives briefly the history of the steps leading to the creation of this reservoir system, and a description of the survey. 3300 w. Technograph, No. 15—1900-1901. No. 40996 D.

Reservoirs and the Control of the Lower Mississippi. Maj. C. McD. Townsend. Discussion of a paper on this subject by James A. Seddon. 6400 w. Jour W Soc of Engrs—April, 1901. No. 40981 D.

Nile.

The Nile Irrigation Works. An illustrated account of the work being done at a cost of $25,000,000. 1200 w. Sci Am—May 4, 1901. No. 40743.

Waterways.

Administration, Construction, and Operation of New Waterways in Austria (Verwaltung, Bau, und Betrieb der zu Erbauenden Wasserstrassen in Oesterreich). Prof. A. Oelwein. A review of the work upon the Danube-Elbe canal, the Danube-Oder canal, and other waterways aggregating more than 1,000 miles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—April 19, 1901. No. 41134 B.

MATERIALS.

Asphalt.

The Municipal Asphalt Plant at Winnipeg, Manitoba. R. N. Ruttan. On the cost of the plant and its operation. 1500 w. Am Gas Lgt Jour—May 6, 1901. No. 40783.

Building Stones.

The Building Stones and Marbles of Ireland. An illustrated article, giving information concerning the stone deposits, and development of the quarries. 2300 w. Stone—April, 1901. No. 40972 C.

The Building Stones of London. Summary of an article in *The Quarry*. The older structures used material of the limestone class, because of the great expense in working the harder varieties. Gives information relating to their wearing qualities, modern appliances for quarrying and working have caused granite to be used for more recent buildings. 3000 w. Stone—April, 1901. No. 40973 C.

Cement.

A Historical Sketch of Slag Cement. William Kendrick Hatt. From a paper before the Indiana Soc. of Engrs. An elementary statement of the nature and properties of slag cements. 2200 w. Munic Engng—May, 1901. No. 40684 C.

Effect of Different Methods of Molding Upon the Strength of Cement. Ira O. Baker. Reports the results of experimental tests made to compare methods. 1000 w. Technograph, No. 15—1900-1901. No. 41004 D.

The Portland Cement Industry in New York. Edwin E. Eckel. Briefly states the early history of the industry, and reviews the plants and materials. 6000 w. Eng News—May 16, 1901. No. 40950.

Concrete.

The Production of Concrete Under New York State Specifications. Discussion of the requirements most likely to ensure a uniform quality of cement, thorough mixing of the cement and sand, and the most economical proportions of mortar and stone. 1500 w. Eng Rec—May 11, 1901. No. 40866.

Estimating.

Tables for Estimating Amount and Cost of Materials and Labor for Buildings. Louis F. Brayton. Presents a method given by the writer in a thesis for the degree of Bachelor of Science in Architectural Engineering. 900 w. Technograph, No. 15—1900-1901. No. 41006 D.

Fire-Resisting.

The Results of Some Tests with Fire-Resisting Materials. Ellis Marsland. Read before the Soc. of Archts., London. Account of tests and experiments conducted by the British Fire Prevention Committee. 4500 w. Archt, Lond—May 3, 1901. Serial. 1st part. No. 40861 A.

Iron Protection.

Practical Experience with Rust Prevention (Praktische Erfahrungen über Rostschutzmittel). Dr. T. Koller. A discussion of the action of the atmosphere upon metallic structures, describing the composition of numerous protective coatings. 3500 w. Glaser's Annalen—April 15, 1901. No. 41117 D.

Protection of Ferric Structures. M. P. Wood. A review of notable instances of failure to protect ferric structures from corrosion, and also instances of success, with discussion of coatings generally used. 20000 w. Trans Am Soc of Mech Engs, No. 886—May, 1901. No. 41075 D.

Long Columns.

Formulas for the Resistance of Long Columns. A discussion on the assumptions at the base of various theoretical formulas for the resistance of long columns and a statement of reasons for preferring a curve based on results of tests of full size columns. 1500 w. Eng Rec—May 18, 1901. No. 40961.

The True Formula for Buckling (Die Richtige Knickformel). J. Kübler. A further contribution to this much discussed subject, with table of coefficients for the author's formula. 1500 w. Zeitschr d Ver Deutscher Ing—April 20, 1901. No. 41126 D.

Wood.

Factors Which Cause the Decay of Wood. Prof. Hermann von Schrenk. The subject is discussed under the heads of structure, chemical nature, decay, fungi, preventive measures. Ill. 5600 w. Jour Soc of Engrs—April, 1901. No. 40978 D.

MEASUREMENT.

Instruments of Precision.

A Few Instruments of Precision at the Paris Exposition of 1900. William E. Reed. Describes exhibits in this line. 4300 w. Trans Am Soc of Mech Engrs, No. 905—May, 1901. No. 41094.

Theodolite.

The Heyde Geared Theodolite (Heyde's Neuer Zahnkreis-Theodolit). W. Wojtan. The instrument is made with toothed limb, enabling very accurate and positive movements to be made; it is especially adapted for geodetic work. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—May 10, 1901. No. 41139 B.

Tripod-Heads.

Notes on Tripod-Heads, with Reference to Mr. Dunbar D. Scott's Paper on the Evolution of Mine-Surveying Instruments. John H. Harden. Discusses the improved tripod-legs and the tripod-head. 1000 w. Trans Am Inst of Min Engs—April, 1901. No. 40823 D.

Surveying.

Geological Survey Plan of Operations. Details of the arrangements made for the work of the U. S. Geol. Survey for the fiscal year 1901-1902. 3000 w. Min & Met—May 1, 1901. No. 41013.

MUNICIPAL.

Drainage.

The Drainage Plant of the City of Hanau (Die Entwässerungs Anlage der Stadt Hanau). Ad. Mertz. Illustrating and describing the arrangement of centrifugal pumps driven by direct-connected electric motors. 1000 w. Zeitschr d Ver Deutscher Ing—May 11, 1901. No. 41131 D.

Franchises.

Franchises. H. S. Cooper. An explanation of the meaning of the term, and a discussion of their value and application, as introductory to a series of articles from an equitable and business standpoint. 3000 w. St Ry Rev—May 15, 1901. Serial. 1st part. No. 40959 C.

London Streets.

The State of London Streets. T. Blashill. Discusses the condition of the London streets, and the treatment of streets in Continental cities. General discussion follows. 11000 w. Jour San Inst—April, 1901. No. 41272 F.

Ownership.

Municipal Ownership vs. Private Corporations. Thomas D. Miller. Read at meeting of the Southwestern Gas, Electric and Street Ry. Assn. Discussion of the subject, unfavorable to municipal ownership. 2500 w. Am Gas Lgt Jour—May 6, 1901. No. 40782.

Pavements.

Durability of Brick Streets. W. Blair. Reports examinations made, and considers that if the construction is good, the pavement will prove durable. 3000 w. Brick—May, 1901. No. 40785.

Paving in Boston. F. S. Gore. Describes the kind of paving generally used at the present time, giving the specifications for laying Sicilian Rock asphalt, and information about car tracks. 1200 w. St Ry Rev—May 15, 1901. No. 40958 C.

Some Experiments in Laying Bituminous Macadam. Describes some experimental sections of roadway laid in East Cambridge, Mass. 1800 w. Munic Engng—May, 1901. No. 40681 C.

Sanitation.

On the Drainage, Reclamation and Sanitary Improvement of Certain Marsh Lands in the Immediate Vicinity of Boston. William Lyman Underwood. Describes and illustrates the condition of the "Fresh Pond Marshes" as they now exist, and as they existed before certain sanitary improvements, recently made, were carried out. 3200 w. Tech Quar—March, 1901. No. 40977 E.

The Principles of Municipal Sanitation (Principien der Städtereinigung). Dr. Paul Degener. A study of the wastes of modern cities and the methods of their removal and disposal. Serial, Part I. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—May 3, 1901. No. 41138 B.

Septic Tanks.

The Antecedents of the Septic Tank. Leonard Metcalf. Treats of the evolution and antecedents of the septic tank in their bearing upon and relation to the collateral patent question and the claims being made. 5700 w. Pro Am Soc of Civ Engrs—May, 1901. No. 41268 E.

Sewage.

Discharge of Sewage from Toronto Sewers in 1900. Cecil B. Smith. Describes the method of taking a record of the flow of sewage in dry weather, to establish data on which to base the design of interceptors, trunk sewers, and disposal works. Plates and tables. 1600 w. Can Soc of Civ Engs—Adv. Proof. No. 40926 D.

Modern Methods of Sewage Purification. Information from the recent annual report of the Connecticut Sewerage Commission, concerning the experiments at Manchester, Eng. Ill. 2200 w. Munic Engng—May, 1901. No. 40680 C.

The Sewage Precipitation Works at Providence. Illustrated description of 20 concrete tanks, 5 sludge reservoirs, press house, chemical building and laboratory forming the works for the chemical treatment of the Providence sewage before it is discharged into the river. 2900 w. Eng Rec—May 4, 1901. No. 40720.

Sewers.

Flow in the Sewers of the North Metropolitan Sewerage System of Massachusetts. Continued discussion of paper by Theodore Horton. 500 w. Pro Am Soc of Civ Engrs—May, 1901. No. 41270 E.

Rapid Transit and Sewerage. An account of the changes in sewers in New York, made necessary by the building of the underground road, and the difficulties encountered. 1000 w. Fire & Water—April 27, 1901. No. 40598.

Streets.

Parking Wide City Streets. Robert L. Johnson. An account of work done in the city of Columbus, Georgia, for beautifying and improving the streets. Ill. 1200 w. Eng News—May 16, 1901. No. 40949.

WATER SUPPLY.

Aqueducts.

The Torresdale Conduit at Philadelphia. Illustrated description of a 10½-ft. aqueduct 13,815 ft. long, to discharge 300,000,000 gals. per day. 2000 w. Eng Rec—May 18, 1901. No. 40962.

The Weston Aqueduct of the Metropolitan Water-Works, Boston. Alfred D. Flinn. Illustrated description of aqueduct 13½ miles long, with a daily capacity of 300,000,000 gals., and having a number of special features in concrete construction. 3800 w. Eng Rec—May 4, 1901. No. 40721.

Bacteria.

Changes That Take Place in the Bacterial Contents of Waters During Transportation. George C. Whipple. An account of experimental investigations, the results of which are of practical importance to the water analyst. 2300 w. Tech Quar—March, 1901. No. 40974 E.

Cincinnati.

The New Water Supply of Cincinnati, O. Description of the purification plant, land tunnel, city pumping station, etc., of the works under construction at the village of California, about seven miles above the city. 2500 w. Eng News—May 23, 1901. No. 41202.

Electrolysis.

See Gas Engineering.

Filtration.

A Filtration Plant at Albany, N. Y. William O. Webber. Brief illustrated description of the plant established at the new intake. 1600 w. Trans Am Soc of Mech Engrs, No. 888—May, 1901. No. 41076.

The Water Purification Works of the East Jersey Water Company of Little Falls, New Jersey. George W. Fuller. Illustrated description of a plant for purifying 40,000,000 gals. daily by coagulation and mechanical filtration. The entire plant is built of concrete, the filter tanks being square in order to economize space. 2000 w. Eng Rec—May 11, 1901. No. 40868.

Water-Works of the Catholic Protectory of Philadelphia. Charles G. Darrach. Illustrated description of a slow sand filter remarkably compact in arrangement, with notes on pumping engines driven by compressed air from a central plant a quarter of a mile distant. 600 w. Eng Rec—May 11, 1901. No. 40871.

London.

The New Works of the Southwark and Vauxhall Water Company. Illustrated description. 2000 w. Jour Gas Lgt—May 7, 1901. No. 40922 A.

Management.

Efficient Management and Maintenance of Water-Works Owned by Municipalities or Private Corporations. Benjamin L. Williams, Jr. Urges the importance of attention to details, the installation of meters, etc. 1200 w. Munic Engng—May, 1901. No. 40682 C.

Reservoir.

The Upper Belmont Reservoir at Philadelphia. Illustrated description of a two-basin 72,000,000-gal. reservoir, noteworthy for the piping details and the method of lining the banks and bottoms. 2200 w. Eng Rec—May 25, 1901. No. 41217.

Submerged Pipe.

Submerged Pipe Crossings of the Metropolitan Water Board. Caleb Mills Saville. A description of some of the methods employed. Ill. Also discussion. 10300 w. Jour Assn of Engng Socs—March, 1901. No. 40990 C.

The New Supply of the Cedar Rapids Water Company, Iowa. Illustrated description of the method of laying 864 ft. of 30-in. submerged suction main, with note on a new form of connecting well. 450 w. Eng Rec—May 25, 1901. No. 41214.

Water Meters.

The Cost of Installing a Water Meter System. A. L. Holmes. A paper read before the Mich. Engrs. Soc. Discusses the average cost, and shows that a metered supply will save more than the cost of a new pumping station which would otherwise be needed. 3000 w. Munic Engng—May, 1901. No. 40683 C.

MISCELLANY.

Chemistry.

Chemistry in Its Relations to Engineering. Frank Clowes. Abstract of the "James Forrest" lecture delivered before the Inst. of Civ. Engrs. Shows the advantages engineers have derived from chemical coadjutors, illustrating by instances from various fields. 3000 w. Engr, Lond—April 26, 1901. No. 40812 A.

Explorations.

Engineering Explorations in Montana and Elsewhere in the Rocky Mountains. Francis W. Blackford. Presidential address before the Montana Soc. of Engrs. A review of the explorations, beginning with the expedition of Lewis and Clarke, in 1804. 5800 w. Jour Assn of Engng Socs—March, 1901. No. 40992 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Combination.

Simultaneous Use of Telephone and Hughes System on Telephone Lines (Gleichzeitiger Vernsprech und Hughesbetrieb auf Vernsprech-Verbindungsanlagen). O. Jentsch. A description of the method used between Berlin-Vienna and other cities for the use of the Hughes telegraph system in connection with telephone lines. 1800 w. Elektrotech Zeitschr—April 18, 1901. No. 41164 B.

Printing Telegraph.

The Murray Page-Printing Telegraph. Illustrates and describes this ingenious invention. The fundamental principle is the use of a perforated tape divided into half-inch spaces, each representing a character. This is run through a printer, whose operation is similar to the automatic piano. 1500 w. Sci Am—May 4, 1901. No. 40742.

Signalling.

Recent Developments in Electric Signalling. Reviews the progress made during the last few years in wireless telegraphy; also important improvements in wire-using devices, discussing the Pollak-Virag system, Dr. Pupin's system, and others. 4000 w. Nature—May 2, 1901. No. 40841 A.

Space Telegraphy.

A New Theory of Wireless Telegraphy. Ideas advanced by M. Rudolf Blochmann, in the *Revue Générale des Sciences,* which give light on points not previously explained. 700 w. Elec Rev, Lond—May 17, 1901. No. 41245 A.

Syntonic Wireless Telegraphy. Guglielmo Marconi. Describes fully the successful efforts of the author to tune or syntonise the wireless system, and the recent progress of this system. Ill. 10000 w. Jour Soc of Arts—May 17, 1901. No. 41237 A.

Wireless Telegraphy. S. M. Kintner. Briefly explains the three forms of wireless telegraphy under the heads of conduction, induction, and radiation, and discusses the particular points of the various theories advanced and the development of the systems in use. Ill. 10000 w. Pro Engs' Club of W Penn—March, 1901. No. 40909 D.

Switchboard.

The Switchboard of the German Post Office Telegraph of 50 Double Conductors (Der Klappschrank für 50 Doppelleitungen M. 99 der Deutschen Reichs-Postverwaltung). Giving details of the standard board, plugs, and wiring. 1200 w. Elektrotech Zeitschr—May 2, 1901. No. 41172 B.

Telephone Exchange.

Modern Telephone Engineering. Kempster B. Miller. Read before the N. Y. Elec. Soc. A discussion of engineering problems arising in planning a telephone exchange and a description of methods and means employed in modern practice.

2700 w. Elec Rev, N. Y.—May 4, 1901. Serial. 1st part. No. 40771.

Telephone Rates.

Railroads and Telephone Rates. An editorial statement of the situation of the Bell Companies and the Independents and the competition that would probably result in case the latter united with the railroad interests. 2200 w. R R Gaz—May 24, 1901. No. 41232.

Telephones.

The Acoustic and Electric Constants of the Telephone. Max Wien. Discusses whether in the telephone itself there are causes for the different transmission of different notes, thus affecting the distinctness of speech. 2500 w. Elect'n, Lond—May 10, 1901. No. 41018 A.

Telephony.

Improvements in Telephony (Neuerungen auf dem Gebieteder Telephonie). H. Zopke. With especial reference to improvements in switchboards; also containing an account of the Poulsen telephonograph. 3000 w. Zeitschr d Ver Deutscher Ing—April 20, 1901. No. 41125 D.

The Engineering Side of Telephone Work on the Pacific Coast. An illustrated detailed description of the exchange equipments and operation. 2000 w. Elec Wld & Engr—April 27, 1901. No. 40599.

The New Equipment of the Sandusky Telephone Company. A. E. Dobbs. History and illustrated description. 2200 w. Elec Rev, N. Y.—May 4, 1901. No. 40773.

DISTRIBUTION.

Alternating Currents.

The Solution of Typical Branched Alternating Current Circuits by Complex Quantities. Harold B. Smith. Gives problems designed to illustrate the application of the complex quantity method of calculation. Mathematical. 1600 w. Jour Worcester Poly Inst—May, 1901. No. 41067 C.

Converters.

Frequency Converters. A. S. McAllister. Describes a recently developed method for changing the lower frequency to a value suitable for lighting purposes by the use of "frequency converters," which constitute a special adaptation of induction motors as secondary circuit generators. 1500 w. Elec Wld & Engr—May 11, 1901. No. 40886.

Niagara.

The Distribution and Conversion of Received Currents. Henry Gordon Stott. A brief description of the apparatus and lines generating, transforming and conveying the current from Niagara Falls to the Terminal House at the city limits of Buffalo, with the more important and novel features in the distribution and conversion. Ill. 6000 w. Trans Am Inst of Elec Engrs—April, 1901. No. 40983 D.

Short Circuits.

A Simple Method of Locating a Short Circuit Between Electrical Conductors. Arthur B. Roe. Illustrates and describes a method based upon the law of induction. 1000 w. Am Elect'n—May, 1901. No. 40620.

Transformers.

Circular Diagram for Special Cases of Transformers (Kreisdiagramme für Specielle Fälle des Allgemeinen Transformators). K. Kuhlmann. An examination of the Ossanna diagram, with applications to practical examples showing the agreement of results with those obtained by computation. 4000 w. Elektrotech Zeitschr—April 18, 1901. No. 41163 B.

Switch for Reducing the Loss in Unloaded Transformers (Schaltvorrichtung zur Vermeidung des Leerlaufstromes Unbelasteter Transformatoren). Ph. Scholtes. An illustrated account of the Schuckert device for disconnecting the primary coil when unloaded, as used by the Nuremberg Electric Station. 1500 w. Elektrotech Zeitschr—April 25, 1901. No. 41167 B.

ELECTRO-CHEMISTRY.

Accumulators.

Edison's New Accumulator. Information based upon Edison's British specification. Description of the battery is given with critical remarks. Ill. 1100 w. Auto Jour—May, 1901. No. 41241 A.

Some Notes on the Copper-Cadmium Storage Battery. J. K. Pumpelly. Gives the history of this type of battery. 700 w. W Elect'n—May 4, 1901. No. 40835.

The Edison Storage Battery. Dr. A. E. Kennelly. A statement of the method whereby the weight-efficiency of the accumulator has been increased two and one-half times. Also interview with the inventor. 5500 w. Elec Rev, N. Y.—May 25, 1901. No. 41265.

Assaying.

The Electrolytic Determination of Copper. Thorn Smith. A description of a laboratory method of electrolytic assay. 1700 w. Eng & Min Jour—May 25, 1901. No. 41224.

Bleaching.

Bleaching at the Anode by Electro-Chemical Action. Woolsey McA. Johnson. An illustrated description of experimental work, giving the details of the process. 900 w. Elec Wld & Engr—May 11, 1901. No. 40888.

Carbide.

The Reducing Action of Calcium Carbide (Studien über die Reduzierende Kraft des Calcium Carbides). F. v. Kügelgen. A very full account of experiments with salts of lead, copper, silver, zinc, etc. Three articles, 10000 w. Zeitschr f Elektrochemie—April 11, 18, 25, 1901. No. 41178 each G.

Carbons.

Carbon in Electro-Chemical Operations. A consideration of the necessary conditions which carbons for different purposes should fulfil, and of how the process of manufactures affects the physical and mechanical qualities of the material. 3000 w. Elec Chem & Met—April, 1901. No. 40833 A.

The Development of the Artificial Carbon Industry (Die Entwickelung der Kunstkohlenfabrikation). J. Zellner. A historical review of the various processes for making carbon terminals and electrodes. 3000 w. Zeitschr f Elektrochemie —March 28, 1901. No. 41176 G.

Carborundum.

Carborundum. L. J. Gray. An account of the discovery and early development of the manufacture, describing the furnaces and their working, the appearance of the crystals, etc., with a discussion of the properties which render it so valuable. 5400 w. Engs' Year Bk, Univ of Minn.—1901. No. 40928 C.

Cells.

The Haas and Oettel Hypochlorite Cell. John B. C. Kershaw. Illustrates and describes this cell, and gives figures supporting its claims for efficiency. 1100 w. Elect'n, Lond—May 10, 1901. No. 41017 A.

Electric Smelting.

Is the Smelting of Iron Ore by Electricity Practicable? Editorial discussion concluding that under the most favorable circumstances the cost would be several times as great as with present methods. 1500 w. Eng News—May 2, 1901. No. 40740.

Reduction of Arsenic Ores in the Electric Furnace. Carl Hering. An illustrated description of an electrical process which overcomes the objections to the usual metallurgical processes, enabling the arsenic to be extracted as a metal, and leaving the other metals concentrated in the resulting matte. 2500 w. Elec Wld & Engr—April 27, 1901. No. 40600.

Frasch Process.

The Frasch Electrolytic Process for Nickel, Cobalt and Copper Ores. Describes the method and illustrates a form of apparatus by which it may be carried out. 1200 w. Min Rept—May 9, 1901. No. 40876.

Phonograph.

A New Phonographic Principle (Ueber ein Neues Phonographisches Prinzip). W. Nernst & R. v. Lieben. The electrochemical action of a current upon an endless platinum band or revolving copper disk enables variations in current to be reproduced in a microphone. 2000 w. Zeitschr f. Elektrochemie—April 4, 1901. No. 41177 G.

An Electrochemical Phonograph. An illustrated account from the *Zeitschrift für Elektrochemie,* in which Nernst and V. Lieben describe a minute electrolytic cell, in which voice currents set up imperceptible surface variations on a moving electrode, which may be made to reproduce the vocal sounds. 1500 w. Elec Wld & Engr—April 27, 1901. No. 40601.

Reactions.

Electrochemical Action. C. J. Reed. A study of electrochemical actions, explaining the conditions necessary, the systems, kinds of electrodes, etc. 7500 w. Jour Fr Inst—May, 1901. Serial. 1st part. No. 40719 D.

Refining.

Production of Hydrogen and Oxygen for Industrial Purposes by Electrolysis. Illustrated description of the process and apparatus used. 1300 w. Engr, Lond—April 26, 1901. No. 40811 A.

Some Notes on the Electrolytic Deposition of Copper. H. Sayer and F. S. Spiers. Discusses some of the details which affect the commercial efficiency of copper refining. 900 w. Elec Chem & Met—April, 1901. Serial. 1st part. No. 40834 A.

Smelting.

Electric Furnace for Smelting Iron. Translated from *Echo des Mines et de la Metallurgie.* A resumé of the claims of a recently patented process taken out by the French Electro Metallurgical Society of Froges. 1500 w. Ir & Coal Trds Rev—April 19, 1901. No. 40639 A.

Water.

The Commercial Electrolysis of Water (Die Kommerzielle Elektrolyse des Wassers). W. Dürer. An examination of the practical difficulties met in the electrolysis of water on a large scale, with data as to cost, etc. 1000 w. Elektro-Chemische Zeitschr—April, 1901. No. 41179 G.

ELECTRO-PHYSICS.

Aluminum.

The Influence of Aluminum Upon Iron for Magnets (Ueber den Einfluss von Aluminum-Beimengungen auf die Magnetischen Eigenschaften der Gusseisens). Dr. A. Schweitzer. With tables and diagrams, showing the influence of various percentages of aluminum upon permeability and hysteresis. 1000 w. Elektrotech Zeitschr—April 25, 1901. No. 41168 B.

Coils.

Electro-Magnetic Coils and Plungers.

Rankin Kennedy. Illustrates and describes various cases, treating the combination as an electro-motor. 1600 w. Elec Rev, Lond—April 19, 1901. No. 40635 A.

Electrical Discharges.

The Action of Magnetized Electrodes Upon Electrical Discharge Phenomena in Rarefied Gases. C. E. S. Phillips. Deals with the conditions necessary for the production of a luminous ring in rarefied gases and under the influence of electrostatic and magnetic forces. 1200 w. Elect'n, Lond—April 26, 1901. No. 40802 A.

Magnetic Attraction.

The Mechanical Forces in Dynamos Caused by Magnetic Attraction. Discussion of Mr. B. A. Behrend's paper. 3000 w. Trans Am Inst of Elec Engrs—April, 1901. No. 40986 D.

Radiant Metals.

The New Metals Polonium, Radium, and Actinium (Les Nouveaux Métaux Polonium, Radium, et Actinium). Paul Besson. A general review of the phenomena of the emission of Becquerel rays by certain metals. 3000 w. Soc Ing Civ de France—March, 1901. No. 41181 G.

The Wonderful Becquerel Ray. Edward Booth. Reviews the history of the discovery of these rays, states their characteristics, and gives general information. 2000 w. Min & Sci Pr—May 4, 1901. No. 40896.

Waves.

Electrical Wave Transmission. An illustrated account of the researches of M. I. Pupin on the transmission of electric waves over long-distance air-lines and sub-marine cables. 2000 w. Engng—April 19, 1901. No. 40642 A.

The Rapid Determination of Harmonic Waves (Methode zur Schnellen Bestimmung Harmonischer Wellen). J. Fischer-Hinnen. Deriving equations for use in plotting multiple period waves. 2500 w. Elektrotech Zeitschr—May 9, 1901. No. 41175 B.

GENERATING STATIONS.

Accumulators.

See Electrical Engineering. Electrochemistry.

Alternators.

Compounding of Alternators by Compensating Exciter. Ernst J. Berg. Explains the theory of automatic compensation, and gives an illustrated description of the method employed in the machine represented. Also editorial notes. 1900 w. Elec Wld & Engr—April 27, 1901. No. 40602.

Regulation of Alternators Under Variable Reactive Loads. George W. Redfield. Discusses the problem of alternator regulation. 3000 w. Technograph, No. 15—1900-1901. No. 41003 D.

American Stations.

Two Examples of Modern American Central Stations. Alton D. Adams. Illustrated detailed descriptions of the Atlantic Avenue Stations of the Boston Edison Company, and the arc lighting plant of the Hoboken Division of the United Electric Company of New Jersey. 5600 w. Am Elect'n—June, 1901. No. 41211.

Boston Edison System.

The Edison System in Boston—Its Development and Present Status. E. S. Mansfield. An illustrated detailed description showing the development and standing of one of the most important and successful systems in the United States, using the latest and best methods. 18500 w. Elec Wld & Engr—May 18, 1901. No. 41071.

California.

A Steam-Driven Electrical Transmission Plant. J. R. Cravath. Illustrates and describes the 22,000-volt system of the United Electric Gas and Power Company at Santa Monica, California. 1400 w. Am Elect'n—June, 1901. No. 41209.

Electricity in San Mateo County, California. C. H. Pennoyer An illustrated detailed description of the installation, and the arrangements made for generating electricity until the transmission lines could be extended to bring current from the Standard Electric Co. 2500 w. Jour of Elec—April, 1901. No. 41029.

Dynamos.

Direct-Current Dynamos in Parallel. Alton D. Adams. Suggestions of importance for their operation. Ill. 1200 w. Am Elect'n—May, 1901. No. 40626.

The Relation Between Voltage and Speed in a Shunt Dynamo. H. B. Poynder and H. E. Wimperis. The chief object of the paper is to point out two valuable deductions to be drawn from the magnetization curve by single graphical treatment. 2000 w. Engng—May 3, 1901. No. 40844 A.

Electricity Works.

Barnes and Mortlake Electricity Works. Illustrated detailed description, with account of opening ceremony. 2500 w. Elec Engr, Lond—May 3, 1901. Serial. 1st part. No. 40862 A.

Great Grimsby Municipal Electricity Works. An illustrated detailed description. 2000 w. Elect'n, Lond—May 17, 1901. No. 41243 A.

Equipment.

Recent Development in Central Station Equipment. P. Junkersfeld. Abstract of a lecture delivered before the Engng. Col. of the Univ. of Illinois. Recent developments in distributing systems and apparatus, and in other fields are briefly considered. 1400 w. W Elect'n—April 27, 1901. No. 40606.

Fulham, London.

An English Combined Central Station and Destructor Plant. Illustrated detailed description of the plant of the borough of Fulham, London. 4400 w. Elec Wld & Engr—May 4 1901. No. 40788.

Generating Set.

Generating Set of 200 Kilowatts of the Société Alsacienne (Groupe Electrogèue de 200 Kilowatts de la Société Alsacienne de Constructions Mécaniques). Detailed description of tandem compound engine and continuous current generator, both made by the same company and exhibited at Paris. 1200 w. 1 plate. Génie Civil—April 27, 1901. No. 41102 D.

Hartford.

The Hartford, Conn., Electric Light Company's System. An illustrated detailed description of a modern and complete generating and distributing system, possessing features of interest. 2800 w. Elec Rev, N. Y.—May 18, 1901. No. 41058.

Heating.

Design of Pipes for Hot-Water Heating from Central Stations. Alton D. Adams. Discusses the various problems to be met and their solution. 2500 w. Elec Rev, N. Y.—May 18, 1901. Serial. 1st part. No. 41059.

Heating of Electrical Machinery Under Two Regularly Alternating Conditions of Load. Edwin Rust Douglas. The aim of the article is to show that, from a knowledge of certain constants of a machine, its performance under any unusual conditions of load may be predicted with accuracy, and to explain the determination of those constants. 2500 w. Elec Wld & Engr—May 11, 1901. No. 40889.

Load Diagrams.

A Station Load Diagram. C. R. Van Trump. Extracts from a paper read before the Nat. Elec. Light Assn. Shows a simple and effective method of tabulating station data, showing the advantage of such records. Ill. 1500 w. Elec Rev, N. Y.—May 25, 1901. No. 41264.

Rates.

The Foresee (4-C) System of Charging. L. R. Wallis. Extracts from a paper read before the Nat. Elec. Lgt. Assn. Discusses briefly various proposed plans and explains the system given the name of this title, showing how it meets the needs of the public. 2500 w. Elec Rev. N. Y.—May 25, 1901. No. 41262 A.

Regulator.

An Improved Automatic Regulator (Ein Neuer Automatischer Regulator). B. Krausse. Describing an improved automatic device for use with shunt regulators. 1200 w. Elektrotech Zeitschr—May 9, 1901. No. 41174 B.

Richmond, Va.

Electric Power Station of the Virginia Electrical Railway & Development Co., Richmond, Va. Illustrated description of one of the largest plants in the south. 1500 w. Eng News—May 2, 1901. No. 40739.

St. Croix.

The Plant of the St. Croix Power Co. of Wisconsin. Discussion of Henry Floy's paper. 5500 w. Trans Am Inst of Elec Engrs—April, 1901. No. 40987 D.

The Power Development and Transmission of the St. Croix Power Company, St. Croix, Wis. John Lycee Harper. Illustrated description of the 27-mile, 25,000-volt transmission of power for the lighting of St. Paul, part of the transmission line being underground. 3000 w. Engs' Year Bk, Univ of Minn—1901. No. 40931 C.

St. Lawrence.

Water-Power Development at Mille Roches, Ont. Illustrated description of a 4,000 H.-P. plant on the St. Lawrence, utilizing a head of only 20 to 30 ft. 2500 w. Eng Rec—May 11, 1901. No. 40869.

Short-Circuiting.

Short-Circuiting and Starting of Alternating Current Motors (Ueber den Kurzschluss und Anlauf von Drehstrommotoren). R. Goldschmidt. Deducing formulas for computing the short-circuiting for different periodicities, and magnetic conditions. 4500 w. Electrotech Zeitschr—April 18, 1901. No. 41161 B.

A Phenomenon in the Short Circuiting of Alternators (Ueber ein Phänomen bei Kurzschluss von Drehstrommaschinen). E. Rosenberg. A graphical examination of the pressure in short-circuited alternators, using solid geometry; with tables and diagrams. Two articles. 6000 w. Elektrotech Zeitschr—April 25, May 2, 1901. No. 41166 each B.

Station Economy.

Central Station Economy. The first of a series of articles calling attention to matters affecting the cost of operation. 1500 w. Elec Rev, Lond—April 19, 1901. Serial. 1st part. No. 40636 A.

Testing Generators.

Testing Direct Current Generators in the Power House. Cloyd Marshall. Points on the erection and testing, when it is necessary that it should fall upon the station engineer. 2000 w. Engr, U. S. A.—May 1, 1901. No. 40665.

Tramway Station.

See Railways and Tramways, Motive Power.

Vehicle Station.

See Mech. Engineering, Automobilism.

LIGHTING.

Arc Lamps.

Regulation and Adjustment of Arc Lamps. M. E. Chester. Describes the types of arc lamps in use, and the methods of regulation. 3000 w. Technograph, No. 15—1900-1901. No. 40994 D.

Arc Lighting.

Recent Developments in Arc Lighting. George D. Shepardson. Reviews the history of arc lighting. 2100 w. Engs' Year Bk, Univ of Minn—1901. No. 40933 C.

Combined Plant.

A Combined Electric Lighting and Steam Heating Plant. An illustrated description of a plant in Springfield, Ohio, where incandescent and arc lamps and steam radiators are all supplied from one power house. 4000 w. Am Elect'n—May, 1901. No. 40619.

Regulations.

The Board of Trade and Electric Lighting. Review of the expert evidence in an application for an alteration in one of the Board of Trade (England) regulations, providing that "no change should be made in the pressure of the supply to any premises . . . except with the consent of the consumer." 1600 w. Nature—April 18, 1901. No. 40627 A.

Street Lighting.

Thirteen Years' Experience with Municipal Street Lighting at Chicago, Ill. Edward B. Ellicott. An official report of results obtained and benefits derived from the service, with a comparison with the cost under private contract. 1700 w. Eng News—May 2, 1901. No. 40738.

Vapor Lamp.

Notes on the Cooper Hewitt Lamp. Peter Cooper Hewitt. A brief illustrated article giving curves showing the characteristics of brilliant vapor tube lamps. Also editorial comments. 2000 w. Elec Wld & Engr—April 27, 1901. No. 40604.

MEASUREMENT.

Direct Currents.

The Transformer for Measuring Large Direct Currents. Harris J. Ryan. Presents a method for large direct current calibrations that employs the transformer for comparing the values of large and small currents in terms of the ratio of transformation and the reading of the instrument used for measuring the small current. 2800 w. Trans Am Inst of Elec Engrs—April, 1901. No. 40984 D.

Electro-Dynamometer.

The Construction of an Electro-Dynamometer. S. M. Kintner. Illustrated description of instruments built by the students of the Western Univ. of Penn. 1300 w. Am Elect'n—May, 1901. No. 40624.

Frequency.

A Frequency Indicator, Power Factor Indicator, Wave Form Indicator, and the Thomson Load Meter. Brief illustrated descriptions of apparatus exhibited at the recent *conversazione* of the Am. Inst. of Elec. Engrs. 1000 w. Elec Rev, N. Y.—April 27, 1901. No. 40596.

Galvanometers.

An Inexpensive Mirror Galvanometer. A. P. Carman. Describes the details of construction, the cost, and the performance. Ill. 700 w. Technograph, No. 15—1900-1901. No. 41000 D.

Notes on the Use of the Differential Galvanometer. C. W. S. Crawley. Read before the Inst. of Elec. Engrs., England. Explains how this instrument may be effectively used for modern work. Ill. 2000 w. Elect'n, Lond—May 17, 1901. No. 41244 A.

Lost Work.

The Measurement of Lost Work in Dynamos (Messung der Arbeitsverluste in Dynamomaschinen). W. Penkert. With tables and diagrams showing the losses due to friction, eddy currents, and hysteresis. 2000 w. Elektrotech Zeitschr—May 9, 1901. No. 41173 B.

Meters.

Commercial Electric Meters. Guy Richardson Radley. Discusses the requirements, care, testing, etc. 3000 w. Technograph, No. 15, 1900-1901. No. 41-007 D.

Electric Meters for Various Rates (Elektricitätszähler für Mehrere Tarife). H. Aron. Describing a form of Aron meter for use when different rates are charged for current in different parts of the day. 1800 w. Elektotech Zeitschr—May 2, 1901. No. 41171 B.

Notes on Meter Testing. Arthur T. Smith. Hints on the testing of electric meters. 1200 w. Elec Rev, Lond—May 3, 1901. No. 40860 A.

Prony Brake.

Portable Prony Brake (Einstellbare Bandbremse). F. Hubert. A simple form of Prony brake, arranged with release to prevent the band from gripping the pulley, and adapted for ready application to electric motors. 1200 w. Elektrotech Zeitschr—April 18, 1901. No. 41162 B.

Recorder.

Voltage and Current Recorder. Frank W. Springer. Illustrated description of a device for recording the instantaneous values of current, or pressure, or both. 2100 w. Engs' Year Bk, Univ of Minn—1901. No. 40929 C.

Standardization.

Standardization of Electrical Apparatus. H. F. Parshall. From *Traction and Transmission*, London. Suggests the standardization of the conditions of output, such as rise of temperature, regulation, efficiency, etc., and outlines the method. 3300 w. W Electn—April 27, 1901. No. 40608.

Testing.

The Testing of Iron at the Schuckert Works (Fabrikations massige Eisen prüfungen bei der Elektrizitäts-A-G. vormals Schuckert & Co., Nürnberg). J. A. Mollinger. A description of the methods employed for investigating the magnetic properties of iron for electrical constructions. 2000 w. Electrotech Zeitschr—May 2, 1901. No. 41170 B.

POWER APPLICATIONS.

Coke Works.

Electrical Plant at an Austrian Coke Factory. A Hartmann, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Illustrated description of the coking plant at the Orlau-Lazy Colliery. 1000 w. Col. Guard—May 10, 1901. No. 41040 A.

Cranes.

The Current Consumption of Electric Wharf-Cranes (Stromverbranch Elektrisch Hafenkrane). E. Krautschopp. Data and results of trials of the electrically driven wharf cranes of various builders in use at the port of Hamburg. 2500 w. Zeitschr d Ver Deutscher Ing—May 11, 1901. No. 41130 D.

Electric Drill.

An Electrically Driven Radial Drill. Illustrated description of a drill designed by Charles E. Willey. 600 w. Am Mach—May 2, 1901. No. 40705.

Factory Equipment.

Polyphase Equipment of Factories. W. Wyld. Read before the Birmingham Local Section of the Inst. of Elec. Engrs. Describes the polyphase alternating-current system and its advantages, and its application to factory driving. Ill. 6200 w. Elec Engr, Lond—May 10, 1901. No. 41016 A.

Requirements of Electricity in Manufacturing Work. William S. Aldrich. Considers briefly some essential features of electric power transmission in manufacturing work. 6300 w. Trans Am Soc of Mech Engrs, No. 898—May, 1901. No. 41086 C.

The New Mill and Power Plant of the Plymouth Cordage Company. Illustrated description of a plant for preparing and spinning binder twine at Plymouth, Mass., special attention being paid to the engine plant and power transmission. 1700 w. Eng Rec—May 11, 1901. Serial. 1st part. No. 40867.

Magnetic Tools.

See Mechanical Engineering, Shop and Foundry.

Mining Plant.

Practical Application of Polyphase Alternate-Circuit Machinery in Coal Mines. Illustrates and describes work carried out successfully at the Park Colliery, Garswood, and Sandwell Park Colliery, near Birmingham. 1600 w. Col Guard—April 19, 1901. No. 40640 A.

Electricity in Mountain Mines. F. W. Brady. Particulars and details of a few plants illustrating the general conditions and difficulties encountered in making different kinds of installations. 4800 w. Trans Am Inst of Elec Engs—April, 1901. No. 40985 D.

The Frongoch Zinc and Lead Mine, Wales. A short illustrated description of the electric plant and the appliances connected with the working of this mine. 1200 w. Eng & Min Jour—May 18, 1901. No. 41024.

Motors.

Dynamo and Motor Troubles and Their Remedies. W. L. Woodmansee. A statement of cases from the experience of the writer. 1500 w. Engr, U. S. A.—May 15, 1901. No. 40941.

The Relative Performance and Efficiency of Direct Current and Induction Motors. W. Elwell Goldsborough. Abstract of a lecture delivered before the Cleveland Electric Club. A comparison of the characteristics and discussion of the performance. 4000 w. Engr, U. S. A.—May 15, 1901. No. 40940.

Typewriter.

An Electric Typewriter. B. C. Washington, Jr. Illustrated description of an application of electricity to the operating of a typewriter, with explanation of the operation. 1100 w. Elec Wld & Engr—May 11, 1901. No. 40887.

Votometer.

The Bardwell Votometer. A. Francis Bardwell and James Hamilton. Explains the Australian and votometer systems of voting, and gives an illustrated description of the machine. 6000 w. Trans Am Soc of Mech Engrs, No. 901—May, 1901. No. 41089 C.

TRANSMISSION.

Australia.

Transmission of Electrical Energy From Brown Coal. Henry C. Jenkins. Considers the case of transmission of the power from Morwell to Melbourne, Australia. 1600 w. N. Z. Mines Rec—March 16, 1901. Serial. 1st part. No. 40796 B.

Grounding.

The Protective Value of Ground Connections (Der Schutzwerth der Erdung). F. Uppenborn. An examination of the conditions under which the grounding of poles for high-pressure currents may prove of value as protection in case of accidents. 4500 w. Elektrotech Zeitschr—April 25, 1901. No. 41169 B.

High Tension.

Some Experiences with High Tension. A. C. Pratt. Observations on troubles and peculiarities incident to this class of work. 2000 w. Engs' Year Bk, Univ of Minn.—1901. No. 40930 C.

The Transmission of Current at High Potential in New York City. Calvin W. Rice. Read before the Nat. Elec. Light Assn. Shows in outline the advances which have made possible the generation of current in one large station, its transmission to sub-stations, and local distribution from each such center, describing the system in New York. 2000 w. Elec Rev, N. Y.—May 25, 1901. No. 41263.

Poles.

Conductor Poles of Iron and Wood (Leitungsmasten aus Eisen und Holz). J. Herzog and C. Feldmann. Illustrating several forms of combination poles constructed with base of structural iron and mast of wood. 2000 w. Zeitschr d Ver Deutscher Ing—May 11, 1901. No. 41-132 D.

Power Transmission.

Electrical Transmission of Power From Mines. F. C. Caldwell. Read before the Ohio Inst. of Min. Engrs. The methods and principles which govern it and limit the profitable distance to which it may be applied. 2000 w. Mines & Min—May, 1901. No. 40690 C.

Regulation.

A Simple Diagram Showing the Regulation of a Transmission System for Any Load and Any Power Factor. F. G. Baum. A graphical study of certain problems, with computations and editorial notes. 2500 w. Elec Wld & Engr—May 11, 1901. No. 41072.

MISCELLANY.

Constitution.

Proposed Constitution of the American Institute of Electrical Engineers. Copy of proposed Constitution to be brought up for consideration at the annual meeting, May 21, 1901. 5500 w. Trans Am Inst of Elec Engr—April, 1901. No. 40988 D.

Exposition.

Electricity at the Pan-American Exposition, Buffalo, N. Y. An illustrated review of the plans executed and under way at Buffalo. 7000 w. Elec Wld & Engr—May 4, 1901. No. 40791.

Japan.

Japanese Electrical Work. R. G. Mayse. An account of points observed during a recent visit. Ill. 1500 w. W Elect'n—April 27, 1901. No. 40607.

Sandwich Islands.

Electricity in the Sandwich Islands. F. E. Grain. An account of recent progress, and present conditions. 2200 w. Elec Wld & Engr—May 4, 1901. No. 40790.

GAS ENGINEERING

Acetylene.

Acetylene Lighting Plants for Villages. Information furnished by Russell C. Miller, as to the selection of apparatus and the cost of producing gas. 1600 w. Met Work—May 4, 1901. No. 40832.

Address.

President's Address Before the Institution of Gas Engineers. W. R. Herring. The address deals with topics which the writer considers have an important bearing on future prosperity of the industry. 7000 w. Gas Wld—May 4, 1901. No. 40915 A.

Analysis.

The Analysis of Furnace Gases. A. W. Watson. Illustrates and describes the use of Hempel's apparatus in the analysis of chimney gases. 1700 w. B C Min Rec—May, 1901. No. 40875 B.

Blast Furnace Gases.

See Mining and Metallurgy, Iron.

Burners.

Observations on Gases Burned in Slit and Welsbach Burners. Dr. H. Bunte. Abstract. Experimental results are given and discussed. 1500 w. Gas Wld—May 11, 1901. No. 41015 A.

Distribution.

Gas Distribution as Viewed by an Electrical Man. Hubert S. Wynkoop. A discussion of pressure regulation, with diagrams. 1800 w. Am Gas Lgt Jour—May 6, 1901. No. 40781.

Electrolysis.

Electrolysis of Water and Gas Pipes. W. W. Brigden. Read before the Mich. Engng. Soc. Relates experience in Battle Creek, Mich., and in other places, and discusses the cure. The advantage of the double trolley is shown, and means of increasing the life of water and gas pipes discussed. 4200 w. Munic Engng—May, 1901. No. 40685 C.

The Electrolysis of Gas and Water Pipes. M. Claude. Some new ideas as to the electrolytic mode of action of the return currents of transmission installations. Ill. 4300 w. Engng—May 3, 1901. Serial. 1st part. No. 40850 A.

Gas Power.

Electric Light and Power Station at Halle (Elektrische Kraft und Licht Centrale der Werschen-Weissenfelser Braunkohlen Aktien Gesellschaft in Halle a. S.). O. Gähring. Showing the advantages of using the gas produced in the dry distillation of lignite as fuel for internal combustion motors. 2500 w. Glückauf—May 11, 1901. No. 41154 B.

Gas Practice.

Some Differences Between British and Continental Gas Engineering. C. E. Brackenbury. Read before the Inst. of Gas Engrs. The comparison is more favorable in most respects to the Continental practice. Discussion. 11000 w. Gas Wld —May 4, 1901. No. 40919 A.

Glasgow Exhibition.

Gas at the Glasgow Exhibition. A brief illustrated account of the exhibits in this field, still incomplete. 3300 w. Gas Wld —April 27, 1901. No. 40803 A.

The Glasgow Exhibition. An account of the lights, the exhibition of domestic and other gas appliances, etc., with editorial on the excellence of the high-pressure gas lighting. 6800 w. Jour Gas Lgt —April 30, 1901. No. 40864 A.

Incandescence.

A New Method for Illuminating with Incandescent Gas Mantles. Frederic Egner. An illustrated description of the Selas Light, with remarks on the recent improvements in gas-lighting appliances. 1700 w. Am Gas Lgt Jour—May 13, 1901. No. 40883.

Liquor.

Analysis of Leeds Gas Liquor. Arthur W. Cooke, in the *Journal of the Society of Chemical Industry*. Explains methods of analysis. 1800 w. Gas Wld—April 20, 1901. No. 40632 A.

Meters.

The Proportional Station Meter. George W. Barnes. Read before the Ohio Gas Lgt. Assn. Describes the operation of the proportional meter, and discusses its adaptability to the duties of a station meter. General discussion. 3600 w. Pro Age—May 1, 1901. No. 40699.

Natural Gas.

The Indiana Natural Gas Field. A. S. Moon. Reviews the conditions and troubles at the beginning of the natural gas industry and gives an illustrated description of two recent pumping stations. 3200 w. Power—May, 1901. No. 40672.

Purification.

Further Notes on Purification of Gas. S. Carpenter. An article prepared for students and young gas managers. On the testing for ammonia and other impurities. 1900 w. Jour Gas Lgt—April 23, 1901. Serial. 1st part. No. 40792 A.

Purification, and Method of Working Purifiers. B. W. Smith. Read before the Inst. of Gas Engrs. The paper is addressed to managers of small works, and deals with points of importance in the work that have come within the writer's large experience. Discussion. 1200 w. Gas Wld—May 4, 1901. No. 40918 A.

The Quantitative Estimation of Hydrogen Sulphide in Illuminating Gas. C. C. Tutwiler. Illustrated description of apparatus devised for the rapid analysis of gases. Its action depends upon the reaction between hydrogen sulphide and iodine. 1500 w. Am Gas Lgt Jour—April 29, 1901. No. 40605.

Supply.

Modern Gas Practice. Abstract report of the discussion of Mr. H. E. Jones' paper, read at the recent meeting of the Inst. of Civ. Engrs. 5300 w. Jour Gas Lgt—April 30, 1901. No. 40863 A.

Modern Practice in the Manufacture and Distribution of Gas. H. E. Jones. Abstract of a paper read before the Brit. Inst. of Civ. Engs. Briefly considers the cost, enrichments, purification, gasholders, and important advances. 2200 w. Gas Wld—April 20, 1901. No. 40630 A.

Tar.

Noxious Vapors From Tar Distillation. Extract from a report by John Craven and W. H. Coleman. Describes experimental work with the view of effecting more complete purification and doing away with inefficient methods. 2400 w. Gas Wld—April 20, 1901. No. 40631 A.

Water Gas.

Notes on Water Gas Manufacture. Thomas Holgate. Read before the Inst. of Gas Engrs. The paper deals with the Dellwik system, and the Strache system, and gives a large amount of information obtained by experiment and analysis. Discussion follows. Ill. 13000 w. Gas Wld —May 4, 1901—No. 40917 A.

Some Notes on the Conditions Which Prevail Within a Carburetted Water Gas Plant. W. J. Atkinson Butterfield. Read before the Inst. of Gas Engrs. Gives suggestions for improving the present results of the working of their plants. Discussion. 6400 w. Gas Wld—May 4, 1901. No. 40920 A.

Water Gas and Other Combustible Gases. Joh. Körting. Abstract translation of a communication to the Assn. of German Engrs. 2300 w. Jour Gas Lgt —April 30, 1901. Serial. 1st part. No. 40865 A.

MARINE AND NAVAL ENGINEERING

Barges.

Screw Barges. Illustrates and describes an interesting arrangement devised by H. Barcroft, of Newry, England, and adopted on some of the waterways of the United Kingdom. 1000 w. Sci Am Sup—May 4, 1901. No. 40745.

Bulkheads.

Electrically Controlled Bulkhead Doors. George E. Walsh. Information concerning the successful working of the apparatus on the U. S. cruiser "Atlanta," and the importance of the system. 1000 w. Am Elect'n—May, 1901. No. 40621.

"Celtic."

Launch of the New White Star Steamship "Celtic." Fine illustrations, with brief description. 350 w. Marine Engng —May, 1901. No. 40760 C.

Chain Towing.

The Steamers of the Bavarian Chain Towing Company (Die Kettendampfer der Kgl. Bayerischen Kettenschleppschiffahrt). With details of the engines and chain drum of these powerful towboats. 3000 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 27, 1901. No. 41126 D.

Cruisers.

New French Armored Cruisers "Leon Gambetta," "Jules Ferry," and "Victor Hugo." Particulars of these vessels as compared with the Drake class are given; the first installment dealing with the first named vessel. Ill. 1300 w. Engr, Lond —May 17, 1901. Serial. 1st part. No. 41251 A.

Swedish Cruisers with Superposed Turrets. Illustrated description of a vessel embodying novel features in gun placing. 800 w. Engr, Lond—April 19, 1901. No. 40652 A.

Cutter.

Steam Cutter Constructed by the Firm Sachsenberg Bros., Rosslau on the Elbe. Reprinted from *Schiffbau.* Illustrated description. 1000 w. Marine Engng—May, 1901. No. 40761 C.

Destroyers.

United States Torpedo Boat Destroyers "Lawrence" and "MacDonough." Plans and description of these boats now under construction. 1600 w. Marine Engng—May, 1901. No. 40766 C.

Distilling Plant.

Fresh Water Distilling Plant on the U. S. Store Ship "Iris." Illustrated description of this vessel of the U. S. Navy, and the arrangement for distilling. 1500 w. Marine Engng—May, 1901. No. 40765 C.

Economy.

The Progress of Economy in Marine Engineering. W. M. McFarland. A review of marine engineering, noting the lines along which progress has been made. 6400 w. Sib Jour of Engng—May, 1901. No. 41277 C.

Germany.

Germany's Progress as a Shipbuilding Nation. Edouard Lockroy. An account of the rapid development and the causes. 4000 w. Naut Gaz—May 9, 1901. No. 40877.

Japan's Navy.

Japan's Magnificent Navy. Dr. William Elliott Griffis, in Boston *Transcript.* An interesting outline of the growth of one of the largest and most powerful among the world's nations. 2000 w. Naut Gaz—May 2, 1901. No. 40840.

The Navy of Japan. Samuel E. Moffett. An illustrated account of the growth and present condition of the navy, which is unquestionably the first naval power in the far East. 2500 w. Rev of Revs—May, 1901. No. 40656 C.

Launching.

Not an Ordinary Launching. Illustrated description of the launching of the "Denver," the largest vessel ever built at the Wilmington works, Delaware. 1000 w. Marine Rev—May 2, 1901. No. 40837.

Liners.

Haverford and Merion. A description of two liners about to be launched in Scotland. Ill. 1500 w. Marine Rev—May 2, 1901. No. 40836.

Marine Engines.

The Marine Steam Engine. William Frederick Durand. Hints relating to the overhauling, adjustment and repair of marine machinery. 4300 w. Marine Engng —May, 1901. No. 40768 C.

The S. S. Port Royal and Port Antonio. Illustrated description of triple expansion engines for two new steamers built for the development of British trade with the West Indies. 1600 w. Engr, Lond—May 3, 1901. No. 40858 A.

Naval Scouts.

Naval Scouting and Despatch Vessels. S. Eardlay-Wilmot. Remarks called out by the paper on "A Design for a Fast Scout," by Vice-Admiral Fitzgerald, and its discussion, and not favorable to special vessels. 1400 w. Engr, Lond—April 26, 1901. No. 40808 A.

River Steamers.

River Steamer. General Pando. Illustrated description of a large stern-wheel steamer for service on the Amazon and its tributaries. 800 w. Engr, Lond—May 3, 1901. No. 40856 A.

Russia's Navy.

Russia's Readiness for War. Charles Johnston. A statement of the relations between Russia, China and Japan, with a comparison of the fleets of Russia and Japan, and also the armies. Ill. 3700 w. Rev of Revs—May, 1901. No. 40655 C.

Schooner.

Fishing Schooner "Rob Roy," Sailing Out of Gloucester, Mass. Illustrations, with description of one of the finest fishing vessels afloat. 800 w. Marine Engng—May, 1901. No. 40762 C.

Shipbuilding.

The Mechanical Equipment of the Shipyard. Prof. J. H. Biles. The second section of Prof. Biles' paper is devoted mainly to a discussion of the tools for working and securing the plating of a ship. 3000 w. Engineering Magazine—June, 1901. No. 41194 B.

Side-Wheel.

Passing of the Oscillating Engine—Sale of the S. S. "Ireland." Illustrated description of this Irish mail steamer, with a record of her dimensions and performances. 1200 w. Marine Engng—May, 1901. No. 40764 C.

Steamboat.

Handsome Excursion Steamboat. Illustrated description of a new 285-ft. vessel for the Detroit and Toledo route. 1100 w. Naut Gaz—May 2, 1901. No. 40838.

Submarine.

Submarine Boat for Polar Exploration. An account of a project to reach the pole in this way; the idea of Mr. Aushutz-Kampfe. 900 w. Naut Gaz—May 23, 1901. No. 41221.

U. S. Navy.

Ten Years' Naval Construction. J. H. Biles. Address before a recent meeting of the Inst. of Naval Architects, in London. Condensed. Reviews the progress of the navy in the United States, giving a comparison of types. 4800 w. Marine Rev—May 9, 1901. No. 40884.

Weights.

Weights of Ships. Theodore Lucas. On systems of weight classifications and calculations. 2500 w. Naut Gaz—May 2, 1901. No. 40839.

Yachts.

Construction of the Yacht "Constitution." Illustrated description of the design and construction. 2800 w. Sci Am—May 11, 1901. No. 40898.

The "Constitution." From the *N. Y. Sun.* A description of the new cup-defender built from the design of N. G. Herreshoff. 2800 w. Naut Gaz—May 9, 1901. No. 40878.

The Launch of "Shamrock II." Illustrated description of the boat with comments. 1400 w. Sci Am—May 11, 1901. No. 40897.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Electromobiles.

Electromobiles and Their Application to Public Transport (Ueber Elektromobilen und deren Verwendung als Oeffent-liches Werkehrsmittel). K. Simons. An examination into the elements of operative costs under the conditions existing in German cities. 4500 w. Elektrotech Zeitschr—April 18, 1901. No. 41165 B.

Exhibition.

Motor Car Exhibition at Islington. Remarks on the notable features, with illustrated descriptions of some of the exhibits. 1700 w. Engr, Lond—May 10, 1901. No. 41035 A.

Fire Engine.

Motor Steam Fire Engine. An illustrated description of a fire engine in England, recently connected from a horse-drawn engine into a self-propeller. 700 w. Engr, Lond—May 6, 1901. No. 41039 A.

Gasoline Carriage.

The Hasbrouck Gasoline Carriage. Illustrated description of a motor carriage propelled by a twin cylinder 6 horse power motor. 900 w. Horseless Age—May 8, 1901. No. 40879.

Ignition.

Two European Magneto-Ignition Systems. Illustrated descriptions of the Simms-Bosch igniter, and the Bergmann igniter. 1600 w. Horseless Age—May 1, 1901. No. 40663.

Liquid Fuels.

Alcohol and Petroleum Essence in Automobilism (L'Alcool l'Essence de Pétrole et l'Automobilism). E. Dieudonné. An examination of the relative calorific power of the liquid fuels with regard to their use in the internal combustion motors of automobile vehicles. 2500 w. Revue Technique—April 25, 1901. No. 41115 D.

Lorry.

Self-Propelled Lorry for Military Purposes. Particulars of an important competition being promoted by the Secretary of State for War with the object of introducing heavy automobiles for military purposes. 800 w. Engr, Lond—May 17, 1901. No. 41255 A.

Motor Traction.

Heavy Motor Traction. Editorial discussion of the progress made, the power required, the wear on roads, etc. 1500 w. Engr, Lond—May 17, 1901. No. 41252 A.

Roads.

Automobiles and Their Relations to Roads. A paper explaining the investigations now in progress to determine the tractive effort necessary to drive self-propelling vehicles over different classes of roads. 2700 w. Eng Rec—May 11, 1901. No. 40870.

Stirling Carriage.

The Stirling 7-H. P. Motor Carriage. Illustrated description of a vehicle comparatively free from transmission mechanism and having a high-power motor. 1200 w. Auto Jour—May, 1901. No. 41-239 A.

Storage Batteries.

Storage Battery Porosity. Thomas J. Fay. A discussion of vehicle batteries, giving a report of tests made and the advantages of batteries of the electric chemical type. 1400 w. Elec Rev, N. Y.—May 18, 1901. No. 41060.

Tires.

Automobile Tires. Frederick A. Barker. Abstract from a lecture delivered at the Automobile Club of America. A discussion of the qualities they should possess, the kinds best suited to heavy vehicles, etc. 900 w. Horseless Age—May 1, 1901. Serial. 1st part. No. 40662.

Traction Engines.

Traction Engines for Transportation of Ores. G. P. Grimsley. Illustrated description of engines in use in California. 700 w. Eng & Min Jour—May 25, 1901. No. 41228.

Transmission Gear.

A Study of Variable Speed Gear (Etude sur les Changements de Vitesse). H. Noalhat. A general discussion of the problem, with details of a solution by the use of speed cones and planetary gears. Two articles, 6000 w. Revue Technique—April 10, 25, 1901. No. 41112 each D.

The Transmission Gear of a Motor Carriage. Herbert Austin. Read before the Cycle Engrs. Inst., London. Gives a brief summary of what the writer considers the essential features of a perfect system, and examines the various leading systems, and sees how far they comply with the requirements set forth. Ill. 7800 w. Auto Jour—May, 1901. No. 41240 A.

Vehicle Station.

The New York Electric Vehicle Transportation Company's New Station. Illustrated description of the new quarters and the numerous details of the service. 2000 w. Elec Rev, N. Y.—May 4, 1901. No. 40770.

HYDRAULICS.

Elevators.

Low Pressure Hydraulic Elevators. William Baxter, Jr. Illustrated detailed description of a vertical cylinder elevator and its operation. 1700 w. Am Mach—May 2, 1901. Serial. 1st part. No. 40704.

Flow.

A Study in Hydraulics. George H. Funkell. A study of interesting problems of the flow of water in pipes. Also discussion. 15000 w. Jour Assn of Engng Socs—March, 1901. No. 40989 C.

Experiments at Detroit, Mich., on the Effect of Curvature Upon the Flow of Water in Pipes. Gardner S. Williams, Clarence W. Hubbell, George H. Fenkell. An illustrated account of extensive experimental investigations, the constructions, apparatus, etc., used. The investigations cover only curves of 90°. 4000 w. Pro Am Soc of Civ Engrs—May, 1901. No. 41267 E.

Hydraulic Forming.

High Pressure Hydraulic Forming and Stamping System (Hydraulisches Hochdruck-Press-und-Pragverfahren). A. Riedler. A description of the Huber system, using the direct pressure of the liquid upon the die and material. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—April 27, May 24, 1901. No. 41127 each D.

Hydraulic Power.

The Use of Hydraulic Power in the Manufacture of Iron and Steel. R. M. Daelen. Read at meeting of the Iron & Steel Inst. On the use of the intensifier and the advantages; the application of high-pressure water to forging presses and the advantages. Ill. 2200 w. Ir & Coal Trds Rev—May 10, 1901. No. 41040 A.

Turbines.

Turbine Building and Turbo-Electric Stations in Switzerland. Prof. F. Prasil. The second section of Prof. Prasil's review deals mainly with the great hydro-electric plants at Chèvres and at Rheinfelden. 3500 w. Engineering Magazine—June, 1901. No. 41197 B.

Hydraulic Turbines at the Exposition of 1900 (Les Turbines Hydrauliques à l'Exposition de 1900). G. Lavergne. A general review of the wheels exhibited at Paris, with especial reference to regulating devices. Two articles, 3500 w. April 20, 27, 1901. No. 41101 each D.

MACHINE WORKS AND FOUNDRIES.

Allis Works.

The New Works of the Edward P. Allis Co., at Milwaukee, Wis. Illustrated description. 2000 w. Eng News—May 23, 1901. No. 41208.

Analysis.

Chemical Analysis as an Aid to Foundry Work. Robert Buchanan. Treats of experiences in regular daily work, showing what chemical analysis can do to help the iron founder. 2000 w. Engng—April 26, 1901. No. 40804 A.

A Study of Balls for Ball Bearings (Etude sur les Billes pour Roulements). A translation of the recent paper presented before the *Verein Deutscher Ingenieure.* 5000 w. Revue de Mécanique—April, 1901. No. 41141 E + F.

Some Experiments on Ball Step-Bearings. C. H. Benjamin. An account of experimental investigations made at the Case School of Applied Science, describing apparatus used. Ill. 1500 w. Trans Am Soc of Mech Engrs, No. 896—May, 1901. No. 41084.

Bicycle Tools.

Machine Tools for Bicycle Manufacture (Machines-Outils pour la Fabrication des Vélocipèdes). G. Richard. Especially devoted to machines for constructing the wheels; mostly of American make. 5000 w. Revue de Mécanique—April, 1901. No. 41140 E + F.

Blue-Printing.

Blue-Printing by Electric Light. H. G. Reist. An illustrated description of an arrangement for printing which gives satisfactory results. 1000 w. Trans Am Inst of Mech Engrs, No. 900—May, 1901. No. 41088.

Cast Iron.

Fluid Iron for Casting. Walter J. May. Suggestions for cupola management, material, and matters necessary to secure good castings. 1100 w. Prac Engr—April 26, 1901. No. 40794 A.

The Constitution of Cast-Iron, with Remarks on Current Opinions Concerning It. H. M. Howe. An attempt to select the most probable working hypothesis, in studying the relation between the chemical composition and physical properties of cast-iron, and some steps toward testing it. 7500 w. Trans Am Inst of Min Engs—April, 1901. No. 40819 D.

Centrifugal Machinery.

Centrifugals at the Glasgow Exhibition. Illustrated description of new features in connection with the exhibit. 2200 w. Engng—May 17, 1901. No. 41258 A.

Connecting Rods.

A New Connecting Rod End. C. W. Hunt. Brief illustrated description. 800 w. Trans Am Soc of Mech Engrs, No. 903—May, 1901. No. 41091.

Crank-Shafts.

Turning Torpedo-Boat Crank-Shafts. Illustrated description of method used. 900 w. Am Mach—May 23, 1901. No. 41223.

Cupolas.

Anthracite Coal as a Cupola Fuel. Edward Kirk. Reviews the history of its use, the manner of charging, the use mixed with coke, etc. 2400 w. Foundry—May, 1901. No. 40660.

Drafting.

Drafting-Room and Shop Systems. Frederick O. Ball. A description of systems, with illustrations. 4000 w. Trans Am Soc of Mech Engrs, No. 904—May, 1901. No. 41092 C.

Rules for a Drawing Office. A. W. Robinson. A copy of revised rules. 1500 w. Trans Am Soc of Mech Engrs, No. 897—May, 1901. No. 41085.

English Shop.

A Progressive English Machine Shop. Robert I. Clegg. Describes the interesting features of the works of Howard & Bullough, at Accrington, manufacturers of textile machinery. 1600 w. Ir Trd Rev—May 9, 1901. No. 40882.

Forgings.

Die Forging. Joseph Horner. The first of a series of articles written with the object of illustrating the methods of stamping engineers' forgings in dies, to the lessening, or exclusion of anvil work, and of hand finishing. 3300 w. Engng—May 3, 1901. Serial. 1st part. No. 40843 A.

Foundry.

A Modern Foundry. Illustrated description of a finely equipped structure at Milwaukee, Wis. 1700 w. Foundry—June, 1901. No. 41280.

Foundry Mixtures.

Notes on Foundry Practice. Edward B. Gilmour. Discusses each of the important elements other than the iron, and its effect. 1400 w. Jour Am Found Assn—May, 1901. No. 40910.

Some Hints on Foundry Mixtures. Frank L. Crobaugh. Suggestions relating to the analysis of iron, scrap, coke, etc. 1400 w. Ir Trd Rev—May 2, 1901. No. 40701.

Furnace.

A Hot Blast Furnace. L. O. Danse. Illustrates and describes a flue system used to heat an enameling furnace with hot blast. 800 w. Am Mach—May 9, 1901. No. 40890.

Gears.

A Gear Curio. Illustrated description of a curiosity in gearing, showing the action of the teeth. 700 w. Am Mach—May 9, 1901. No. 40891.

Bevel-Gear Cutting Machines at Paris. Fred. J. Miller. Illustrated detailed descriptions of various machines for this class of work, showing the practice in different countries. 8800 w. Trans Am Soc of Mech Engrs, No. 893—May, 1901. No. 41081 D.

Gear Molding Machine. An illustrated description of a superior gear molding machine. Its most striking feature is the method of inverting the functions of its leading parts in order to adapt it to the making of either small or large gears. 1000 w. Am Mach—May 9, 1901. No. 40892.

Heavy Machinery.

Moving Heavy Machinery. Suggestions with illustrations. 1800 w. Power—May, 1901. No. 40675.

Ladle.

Electric Travelling Ladle of 20 Tons Capacity (Elektrisch Angetriebener Giesspannenwagen fur 20 t Pfanneninhalt). Illustrated description of heavy electric ladle car built by Seussenbreuner of Düsseldorf. 600 w. Stahl und Eisen—March 15, 1901. No. 41141 D.

Lathes.

The First Large Turret Lathe. Thomas Coulter. An illustrated account of the first large turret lathe built or used in the United States. 1600 w. Ir Age—May 23, 1901. No. 41051.

Turret Lathe Practice. Illustrates and describes a semi-automatic turret lathe and its work. 2200 w. Mach, N. Y.—May, 1901. No. 40677.

Locomotive Works.

Hyde Park Locomotive Works, Springburn, Glasgow. Illustrated detailed description of the largest locomotive manufactory in Europe, and its equipment, with history of the undertaking. 14600 w. Engr, Lond—May 17, 1901. Serial. 1st part. No. 41250 A.

Machine Design.

Discrepancies of Precept in Machine Designing. Leicester Allen. An exposition of the wide divergence and disagreement of authorities over fundamental data and principles. 2500 w. Engineering Magazine—June, 1901. No. 41191 B.

Machine Tools.

A Special Form of Boring and Facing Machine. Walter S. Russel. Brief illustrated description. 400 w. Trans Am Soc of Mech Engrs, No. 906—May, 1901. No. 41093.

Machine Tools for Plates and Angles. Illustrated description of punching, shearing and bending machines driven by electricity. 600 w. Engr, Lond—May 17, 1901. No. 41254 A.

Portable versus Stationary Machine Tools. John Riddell. Illustrated description of some portable machine tools, comparing their work with the stationary tools formerly used. 800 w. Trans Am Soc of Mech Engrs, No. 899—May, 1901. No. 41087.

Tools for Interchangeable Manufacturing. Joseph Vincent. The first of a series of articles illustrating and describing practical points about the design and construction of jigs, tools, and fixtures used for the duplication of machine parts, aiming to show how unnecessary expense and work may be avoided. 2000 w. Mach, N. Y.—May, 1901. Serial. 1st part. No. 40679.

Magnetic Tools.

Electro-Magnets for Iron-Working Establishments. William Baxter, Jr. On the lifting capacity of magnets and the conditions giving the best results. 3700 w. Mach, N. Y.—May, 1901. No. 40678.

Magnetic Planer Clutch. Illustrates and describes a device invented by John Riddell which has been under test for about a year and given high satisfaction. 1000 w. Am Mach—May 2, 1901. No. 40703.

Micrometer Calipers.

The Use of Micrometer Calipers for Regular Machine Shop Gages. John T. Slocomb. An illustrated article explaining the uses made of the micrometer caliper in the machine shop. 1600 w. Am Mach—May 2, 1901. No. 40708.

Molding.

Molding Pulleys with Green Sand Arm Cores. Richard Barnett. Describes the method. Ill. 1300 w. Foundry—May, 1901. No. 40661.

Niles Works.

A Modern German Machine-Tool Shop, the Deutsche Niles Werkzeugmaschinen-Fabrik. Illustrated detailed description of these works in Berlin. 2800 w. Am Mach—May 16, 1901. Serial. 1st part. No. 40938.

Planing Tools.

The Possibilities of the Planing Tool. W. A. Warman and R. B. Cochrane. An illustrated article on the satisfactory use that may be made of the planing tool in removing stock and machining a true surface. 800 w. Am Mach—May 2, 1901. No. 40709.

Roller Bearings.

Notes on Rolling Bearings. William W. Estes. Where roller bearings will effect saving, and the things tending to increase their economy, with discussion of various designs, and record of practical experience with the anti-friction bearings. 6000 w. Jour Worcester Poly Inst—May, 1901. No. 41065 C.

Sand Blast.

Cleaning Metalwork with the Sand Blast. Describes two plants, one consisting of a hoisting engine run backward to serve as an air compressor and delivering air into a boiler acting as a receiver. 1400 w. Eng Rec—May 4, 1901. No. 40724.

Soldering.

Machine Shop Soldering. C. H. Wilcox. On uses made of solder, and methods. Ill. 1000 w. Am Mach—May 2, 1901. No. 40706.

Stamping Machines.

Armature Plate Machines. Illustrated description of modern machines intended for dealing with armature stampings for dynamos and motors. 700 w. Engng—April 19, 1901. No. 40644 A.

Valves.

Globe Valve for Injector Throttle. William Newton. Illustrated description, with suggestions for constructing. 600 w. Am Mfr—May 2, 1901. No. 40759.

Pulley Press Valve. Francis H. Stillman. Illustrates and describes a large press operating valve, believed to be one of the most elaborate ever used to operate the motions of a single hydraulic press. 1000 w. Trans Am Soc of Mech Engrs, No. 894—May, 1901. No. 41082.

Westinghouse Works.

The Works of the Westinghouse Electric and Manufacturing Company. An illustrated detailed description of these interesting works and their fine equipment. 1800 w. Elec Rev, N. Y.—May 11, 1901. Serial. 1st part. No. 40885.

MATERIALS OF CONSTRUCTION.

Leather.

The Leather Industry at the Exposition of 1900 (L'Industrie des Cuirs et Peaux à l'Exposition de 1900). H. de la Coux. With especial reference to the improved processes for rapid tanning exhibited, and the influence upon the product. Two articles. 3500 w. Génie Civil—May 4, 11, 1901. No. 41104 each D.

Teak.

Teak Industry of Siam. Information concerning the teak-lumber business, the most valuable lumber for shipbuilding. 2500 w. U. S. Cons Repts, No. 1041—May 20, 1901. No. 40968 D.

Testing.

Experiments on Bending Notched Bars (Etude Expérimentale sur le Pliage des Barrettes Entaillées). MM. Fremont & Osmond. A review of tests made with scored bars according to the system of M. Fremont. 10000 w. Bull Soc d'Encour—April, 1901. No. 41123 G.

POWER AND TRANSMISSION.

Belting.

Rules Governing the Width of Leather Belting. J. J. Flather. A discussion of the considerations which determine the size of belts, with information relating to strength, care, cost, etc. 3500 w. Engs' Year Bk, Univ of Minn.—1901. No. 40936 C.

Compressed Air.

Compressed Air. J. J. Swann. A lecture before the Brooklyn Engs' Club. Briefly reviews the history of compressed air, its production, transmission and use. 5000 w. Compressed Air—May, 1901. No. 40927.

Diagram for Calculating Compressed Air Pressure. Presents and explains a graphic table intended to facilitate calculations in power transmission. 200 w. Min & Sci Pr—April 27, 1901. No. 40669.

Test of an Hydraulic Air Compressor. William O. Webber. A record of results obtained in some tests at the plant of the Dominion Cotton Mills Company, Limited, at Magog, P. Q., Canada. Ill. 1300 w. Trans Am Soc of Mech Engrs, No. 889—May, 1901. No. 41077.

The D'Auria Air-Compressor. Henry G. Morris. Illustrates and describes a new form of air-compressor, and stating its advantages. 1400 w. Trans Am Inst of Min Engs—April, 1901. No. 40826 D.

Friction.

Friction. Discusses the important laws to be remembered by those having charge of machinery. 1800 w. Engr, U. S. A.—May 1, 1901. No. 40667.

Heating Plant.

A Fan and Furnace School-Heating System. Illustrated description of a plant in an Oshkosh schoolhouse, where air is forced by a fan into a chamber containing hot-air furnaces from which it passes through flues to the rooms. 900 w. Eng Rec—May 18, 1901. No. 40966.

Gas Power.

See Gas Engineering.

Power Plants.

The Power Plants of the Pan-American Exposition. A description of the steam and gas engines and electric power apparatus. 2800 w. Eng Rec—May 25, 1901. No. 41216.

Prony Brake.

See Electrical Engineering, Measurement.

Rolling Disc.

The Mechanics of a Rolling Disc. G.

A. Goodenough. A statement of the problem and its solution. Ill. 2300 w. Technograph, No. 15—1900-1901. No. 41002 D.

Rope Transmission.

A Rope Transmission Plant at Buffalo, N. Y. Illustrated description of the plant at the Spencer Kellogg Linseed Oil Works. 2500 w. Power—May, 1901. No. 40670.

SPECIAL MOTORS.

Diesel Motor.

Some Recent Tests of the Diesel Oil Engine. Bryan Donkin. (Summarized from Prof. Eugene Meyer's report). On experiments made in Sept., 1900, on two vertical single-acting Diesel engines, to test them for efficiency and steadiness. 1500 w. Engr, Lond—April 26, 1901. No. 40809 A.

Gas Engine.

A 1,000 Horse-Power Gas Engine and Compressor. E. E. Eysenbach. Read before the Ohio Gas Lgt. Assn. Describes a gas-engine having four 25 x 48-in. engine cylinders, and two 16 x 24-in. gas compressing cylinders. The pump is rated at 12,000,000 cu. ft. of gas at 315 lbs. in 24 hours, the inlet pressure being 100 lbs. 1200 w. Eng Rec—May 4, 1901. No. 40725.

Efficiency Tests of a One-Hundred-and-Twenty-Five-Horse-Power Gas Engine. C. H. Robertson. Illustrated description of the plant tested and results of tests made in April and May, 1900. Table, cards, curves, and full information. 6800 w. Trans Am Soc of Mech Engrs, No. 907—May, 1901. No. 41095 D.

Lecture to Columbia Students on the Gas Engine. William P. Flint. Presents the advantages of gas engines, discusses the problem of governing, ignition, etc., and briefly reviews the history. 5500 w. Am Mfr—May 2, 1901. No. 40758.

Three Hundred Horse Power Tandem Gas Engine (Dreihundertpferdiger Tandem Gas Engine). V. Schönbach. Description of the Delamare-Deboutteville engine at the Königshof iron works in Bohemia, using blast-furnace gas. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 30, 1901. No. 41156 B.

Ignition.

Liquid Interrupters. James T. Sibley. Gives illustrated description of the Caldwell and Wehnelt types, and reports their use with good results on a gas engine. 800 w. Horseless Age—May 22, 1901. No. 41222.

Pre-Ignitions and Miss-Fires in Oil Motors. Discusses the causes and effects. 3500 w. Prac Engr—April 26, 1901. No. 40793 A.

Speed-Variations.

Speed-Variations Occurring During the Cycles of the Otto Gas Engine and the Diesel Heat Motor. Abstract of the results of thesis work, edited by Prof. Sidney A. Reeve. 1800 w. Jour Worcester Poly Inst—May, 1901. No. 41066 C.

STEAM ENGINEERING.

Boilers.

Stirling Water-Tube Boiler at the Glasgow Exhibition. Illustrated description of two boilers in use at the Glasgow Exhibition for the generation of steam for driving the power plant, one of which is fitted with a Vickar's stoker, while in the other producer gas is used. Also report of trials, and illustrations of tube cleaners. 2800 w. Engng—May 17, 1901. No. 41259 A.

The Boiler and Boiler-Room. W. J. Ranton. On recent improvements in boilers and boiler construction, their care, etc. 2200 w. Power—May, 1901. No. 40674.

The Distribution of Heat in Boilers. Editorial, calling attention to points overlooked and facts seemingly misunderstood. 2200 w. Engr, Lond—May 10, 1901. No. 41036 A.

The Horse Power of Boilers. W. H. Wakeman. A criticism of ideas expressed in an article appearing in this same paper, claiming that there is no such thing as the horse power of a boiler, when considered independently of the engine. 1500 w. Elec, N. Y.—May 22, 1901. No. 41070.

The Thornycroft-Marshall Water-Tube Boiler. Illustrations, with a statement of the advantages claimed. 1500 w. Engr, Lond—May 3, 1901. No. 40857 A.

The Solignac and Grille Marine Boiler (Chaudière Marine de MM. Solignac et Grille). J. Prouteau. Describing this improved form of water-tube boiler, with forced circulation and especial ease of access. 2000 w. Revue Technique—March 25, 1901. No. 41108 D.

The Solignac and Grille System of Instantaneous Boiler-Cleaning (Système de Nettoyage Instantané et sans Arrèt de leur Chaudière à Vapeur). MM. Solignac and Grille. Describing the method by which a powerful circulation is used to clean the tubes of the inventors' water-tube boiler. 2500 w. Soc Ing Civ de France—March, 1901. No. 41182 G.

The Solignac Water-Tube Boiler. Information concerning the boilers of Solignac, Grille and Cie, with estimated comparisons between what they can do and some other types of boilers. Illustrates the construction. 2600 w. Engr, Lond—May 3, 1901. Serial. 1st part. No. 40854 A.

Water-Tube Boilers. Abstract of a paper by R. J. Worth, read at Middlesbrough meeting of the Cleveland Inst. of Engrs., condemning the Belleville boiler, and discussing other types. General discussion.

4000 w. Ir & Coal Trds Rev—May 3, 1901. No. 40851 A.

Water-Tube Boilers. Edwin Griffith. Read before the North-East-Coast Inst. of Engrs. & Shipbuilders. The object of the paper is to consider the present position of water-tube boilers from the point of view of the marine engineer. 5500 w. Engr, Lond—May 17, 1901. No. 41257 A.

Boiler Tubes.

Description of the Manufacture of Seamless Steel Boiler Tubes. C. A. M'Allister. Brief description, with requirements for all seamless cold drawn steam tubes furnished to the U. S. government. 3000 w. Marine Engng—May, 1901. No. 40767 C.

Chimneys.

A Concrete Chimney. Ralph C. Davison. Illustrated description of a chimney built at Elizabethport, N. J., for the Seiger Mfr. Co. It is of the Ransom cold-twisted iron construction, 125 ft. high, with a 9-foot flue. 1000 w. Sci Am—May 18, 1901. No. 40923.

Construction of a Steel Chimney. A. H. Neureuther. An illustrated description of the construction of a stack erected in Peru, Ill. 1800 w. Technograph, No. 15—1900-1901. No. 40999 D.

Stability of a Tall Chimney. Carl Hays. An examination of the stability of a chimney erected at Urbana, Ill., and its maximum pressure on the masonry and on the soil. 1000 w. Technograph, No. 15—1900-1901. No. 41008 D.

Clearance.

A Test of Cylinder Clearance. An account of an exhaustive test to determine the effect of clearance upon the question of steam economy. 4500 w. Power—May, 1901. No. 40673.

Condensation.

Disposing of the Water of Condensation. C. W. Obert. Illustrates and describes various methods of draining of the water. 1400 w. Am Elect'n—May, 1901. No. 40625.

Cooling Tower.

The Zschocke Cooling Tower for Condensing Water. An illustrated description of a tower erected at the station of the Birkenhead Corporation Electric Tramways, which works very successfully. 800 w. Engng—May 10, 1901. No. 41042 A.

Economy.

Economy in Steam Production. C. W. Obert. Discusses the important factors in the cost of steam production. 2300 w. Am Elect'n—May, 1901. No. 40623.

Possible Additional Economics at the Steam End of the Mill. Abstract of a paper by O. C. Woolson, before the New England Cotton Mfrs. Assn., on the economy attainable by careful attention to methods of handling coal and ashes. 1800 w. Eng Rec—May 4, 1901. No. 40723.

Efficiency.

Actual Efficiency in Steam Generation. A. Bement. A study of the conditions involved in the attainment of high efficiency, including the difficult personal element. 3000 w. Engineering Magazine—June, 1901. No. 41195 B.

Engine Tests.

Preliminary Report of the Committee Appointed to Codify and Standardize the Methods of Making Engine Tests. 19500 w. Trans Am Soc of Mech Engrs, No. 891—May, 1901. No. 41079 E.

Test of a 65 H.-P. Bates Corliss Engine. Charles A. Happin. Tests made at the plant of the Twin City Water Works, Urbana. Ill. 1300 w. Technograph, No. 15—1900-1901. No. 41001 D.

Test of a Three Cylinder Steam Engine (Untersuchung einer Dreicylinder Dampfmaschine). H. Lorenz. Details of test of 600 h. p. triple-expansion engine, with and without steam-jackets, at the Portland cement works, at Misburg, near Hannover. 2000 w. Zeitschr d Ver Deutscher Ing—May 11, 1901. No. 41129 D.

Tests of the Hardill Compound Engine. W. J. Childs and O. W. Bodler. Illustrated description of the special features of the engine, with account of tests. 1100 w. Sib Jour of Engng—May, 1901. No. 41278 C.

Flywheels.

Determination of Fly Wheels to Keep the Angular Variation of an Engine Within a Fixed Limit. J. J. Astrom. Attempt to indicate a method by which the regulating capacity of a fly-wheel upon the motion of an engine may be positively determined. 5000 w. Trans Am Soc of Mech Engrs, No. 892—May, 1901. No. 41080 C.

Heating.

See Electrical Engineering, Generating Stations.

Marine Engines.

See Marine and Naval Engineering.

Multiple Expansion.

The Proportions of Cylinders for Multiple Expansion Engines. Alfred Hanssen. A mathematical explanation of the writer's method of finding the actual area of the cylinders. 2200 w. Engng—May 3, 1901. No. 40849 A.

Portable Engines.

Portable Steam Engines (Lokomobilen). H. Dübbel. A discussion of the agricultural type of portable engines, especially with a view to fuel economy. 2000 w. Zeitschr d Ver Deutscher Ing—May 11, 1901. No. 41133 D.

Power Plant.

Starting of a New Power Plant. I. H. Sherwood. Discusses the methods to be observed in putting in operation an installation of steam and electric machinery. 2300 w. Engr, U. S. A.—May 1, 1901. No. 40666.

Recording Machine.

An Automatic Recording Machine. E. C. Oliver. Illustrated description of a machine for recording on a continuous strip of paper the momentary changes of conditions throughout a test of an engine. 1500 w. Technograph, No. 15—1900-1901. No. 41005 D.

Smoke.

Smoke and Grit From Electric and Factory Chimneys. Discusses the subject of recording and diminishing smoke, etc. 1800 w. Elec Rev. Lond—May 17, 1901. Serial. 1st part. No. 41246 A.

Speed Variation.

Theoretical Estimation of the Internal Speed Variation of a 3500 Horse-Power Vertical Cross-Compound Engine. W. L. Abbott. Investigation to determine the amount of variation which would occur in the relative positions of the armatures of alternating current dynamos, and to see if it would be great enough to put the dynamos out of step, or if the amount of cross current would be objectionable. 2700 w. Technograph, No. 15—1900-1901. No. 40993 D.

Steam Engines.

A French Corliss-Type Steam Engine. Illustrated detailed description of a horizontal triple expansion engine driving 1,000 kw. alternator. 1100 w. Am Elect'n —May, 1901. No. 40622.

Horizontal Triple-Expansion Engine (Liegende Dreifachexpansions-Dampfmaschine). M. Schmidt. An illustrated description of an engine of 2,000 to 2,500 h. p., with rope drive. An illustration is given of the special car for the transport of the 24 ft. fly wheel. 1200 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 20, 1901. No. 41124 D.

Modern Practice in Steam Engine Construction. Illustrates and describes recent improvements, with general remarks. The illustrations are mostly of horizontal engines, but only because this type offers a wider range of examples and practice. 5700 w. Am Elect'n—June, 1901. No. 41210.

6000-H. P. Westinghouse Engines for the New York Gas and Electric Light, Heat and Power Company. Illustrated description. 2000 w. Eng News—May 23, 1901. No. 41204.

Steam Heating.

The Development of the Steam Hot Blast System of Heating and Ventilation. B. S. Harrison. A nontechnical description of this system and its development. 1800 w. Engs' Year Bk, Univ of Minn.—1901. No. 40932 C.

Superheating.

Boilers and Engines for Superheated Steam (Kessel und Dampfmaschinen für Ueberhitzten Dampf). H. Hunger. A discussion of the importance of using properly designed engines and boilers if the full benefits of superheating are to be obtained. 2500 w. Zeitschr d Ver Deutscher Ing—April 27, 1901. No. 41128 D.

New German Boilers and Engines for Superheated Steam. Abstract of a paper by Oscar Hunger, before the Soc. of German Engrs., describing the details of boilers and engines best adapted for superheated steam. 2700 w. Eng Rec—May 18, 1901. No. 40967.

Superheated Steam. Ernest H. Foster. Briefly reviews the history of superheating, discusses the increased efficiency and methods. 3700 w. Trans Am Soc of Mech Engrs, No. 909—May, 1901. No. 41097.

The Practical Application of Superheated Steam. George A. Hutchinson. Defines superheated vapor and applies the law to a concrete case, showing the advantage and the economy. Discusses the requirements of a superheater and gives illustrated descriptions of various designs. 7800 w. Trans Am Soc of Mech Engrs, No. 902—May, 1901. No. 41090 D.

Turbines.

The Steam Turbine. An explanation of the action with proof of statements. 1800 w. Power—May, 1901. Serial. 1st part. No. 40671.

Water Hammer.

The "Water Ram" in Blow-Off Pipes. On the importance of keeping the blow-off pipe free from deposits, and the danger of opening and closing valves suddenly; giving an account of an accident which occurred from the water-ram action in a blow-off pipe caused by closing the blow-cock too quickly. 2000 w. Locomotive—April, 1901. No. 41063.

MISCELLANY.

Address.

Presidential Address of William H. Maw, before the Institution of Mechanical Engineers. Abstracted. On the present position of the mechanical engineer. 5000 w. Engr, Lond—April 26, 1901. No. 40816 A.

Aeronautics.

Aerial Navigation (La Navigation Aérienne). E. Dieudonné. Giving an account of the experiments with the aeroplane of Kretz, recently made in the environs of Vienna. 2000 w. Revue Technique—March 25, 1901. No. 41110 D.

Hofman's Flying Machine. Brief illustrated description. 500 w. Sci Am—May 4, 1901. No. 40744.

Baling Cotton.

A Method of Preparing and Baling Cotton in Round Bales of Uniform Lap. John R. Fordyce. Illustrated description of machine and method, and related matter. 3800 w. Trans Am Soc of Mech Engrs, No. 908—May, 1901. No. 41096 C.

Education.

The Training Course for Engineers of the General Electric Company. Thomas Howe. An account of the system of training employed. Ill. 2000 w. Sib Jour of Engng—May, 1901. No. 41279 C.

Ericsson.

Personal Recollections of Captain John Ericsson. Egbert P. Watson. Interesting personal reminiscences heretofore unpublished; also engraving of oil portrait from life. 3000 w. Engineering Magazine—June, 1901. No. 41196 B.

Indexing.

A Method of Filing and Indexing Engineering Literature, Notes, Data, etc. George H. Marr. Describes the use of Dean's Document File. Ill. 2400 w. Trans Am Soc of Mech Engrs, No. 890—May, 1901. No. 41078.

Labor.

Lessons from the Experience of British Organized Labor. F. Brocklehurst. A review of the labor situation in England for the past fifty years, showing the futility of resisting improved machinery and methods. 2500 w. Engineering Magazine—June, 1901. No. 41192 B.

Machinists' Strike.

The Machinists' Strike. Reports from all sections of the country concerning the strike for ten hours' pay in return for nine hours' work. 15000 w. Ir Age—May 23, 1901. No. 41054.

Refrigeration.

Air Circulation in Cold Stores. Madison Cooper. Discusses the distinction between circulation and ventilation, how to promote circulation, and the methods that hinder. 4000 w. Ice & Refrig—May, 1901. Serial. 1st part. No. 40729 C.

A Porto Rico Ice Plant. William E. Groff. Illustrates and describes the plant of the San Juan Ice and Refrigerating Co., and the difficulty met in constructing it. 800 w. Ice & Refrig—May, 1901. No. 40730 C.

Cold Storage Plant in Belgium. Illustrated description of its construction and equipment. 3000 w. Ice & Refrig—May, 1901. No. 40728 C.

Process of Refrigeration. Arthur Pennell. Describes the process briefly. 1100 w. Ice & Refrig—May, 1901. No. 40731 C.

Slide Rule.

The Precision of the Slide Rule. Louis Derr. Gives some precision tests which show that more accurate results than usually credited can be obtained. 900 w. Tech Quar—March, 1901. No. 40975 E.

Ventilation.

Ventilation: Success and Failure of Methods at Present in Use. Christopher Childs. Discusses chiefly the various methods for the ventilation of schools. Also general discussion. 15800 w. Jour San Inst—April, 1901. No. 41273 F.

MINING AND METALLURGY

COAL AND COKE.

Alabama.

The Alabama Coal Fields. Henry McCalley. Their location and characteristics with an account of the early discoveries and development and the present output. Ill. 4000 w. Mines & Min—May, 1901. No. 40694 C.

Anthracite.

History of Anthracite Coal Production in Pennsylvania. A graphic illustration by a chart prepared by William W. Ruley. The article discusses the probable life of these coal fields. 600 w. Min & Met—May 1, 1901. No. 41014.

Chinese Coals.

The Composition of Chinese Coals. M. Monod, in *Moniteur Industriel*. Information concerning the coal-bearing strata, with analyses of samples collected during travels, showing that some of the coals can rival the best known fields. 1300 w. Col Guard—May 17, 1901. No. 41249 A.

Coke.

The Coke Industry in the United States. An advance summary of a report about to be issued by the Census Office, compiled by E. W. Parker. 2400 w. Ir Age—May 2, 1901. No. 40657.

The Electric Plant at the Orlau-Lazy Coke Works (Die Elektrische Anlage in der Cokesanstalt Orlau-Lazy). A. Hartman. An account of a modern coke plant with by-product, ovens and electric charging machinery in Silesia. 1200 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—May 4, 1901. No. 41159 B.

The Manufacture of Coke. Edward W. Parker. Abstracted from the special report of the U. S. Census. Refers principally to the manufacture during 1899, and is limited to the product usually termed "oven cake." 3000 w. Pro Age—May 15, 1901. No. 40943.

Coke Works.

See Electrical Engineering, Power Applications.

Equipment.

Modern Colliery Surface Equipment. Illustrated description of economic coal-mining appliances, as shown in a plant erected in South Wales. 3300 w. Ir & Coal Trds Rev—April 26, 1901. No. 40-818 A.

Germany.

The German Coal and Coke Syndicates and the Reaction in the Iron Industry. An explanation of the changed conditions of industry. 2400 w. Col Guard—April 26, 1901. No. 40807 A.

Internal Heat.

The Development of Heat in Coal Mines (Die Wärmeverhältnisse im Kohle Führenden Gebirge). H. Höfer. A discussion of the ratio of the development of temperature with depth, with especial reference to the striking of a seam of water of 90° F. at a depth of 1150 feet, near Teplitz, Bohemia. Serial. Part I. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 11, 1901. No. 41160 B.

Mexico.

Coal Mining in Mexico. An illustrated description of the development of a coal field in the state of Coahuila, as reported in *Modern Mexico*. 450 w. Col Guard—April 26, 1901. No. 40806 A.

Outcrops.

Coal-Outcrops. Continued discussion of Mr. Catlett's paper, presented at the Canadian meeting. 900 w. Trans Am Inst of Min Engs—April, 1901. No. 40824 D.

Peat.

Swedish Peat-Fuel Machinery. Illustrates and describes the two most important processes of peat manufacture in use. 5000 w. Engr, Lond—May 17, 1901. No. 41256 A.

The Peat Fuel Question in Sweden. Some facts concerning the utilizing of peat, because of the heavy prices of coal. 1500 w. Engr, Lond—May 3, 1901. No. 40855 A.

Pitch.

Across the Pitch versus Up the Pitch. O. E. S. Whiteside. Read at the meeting of the Canadian Min. Inst. Discusses when each method is to be preferred, the manner of operating, etc. 1100 w. Eng & Min Jour—May 18, 1901. No. 41020.

Poland.

The Coal and Iron Industries of Poland. Particulars regarding these industries for the year 1900. 3000 w. Col Guard—May 3, 1901. No. 40853 A.

South Wales.

Coal and Mines of South Wales. A Howells. Read before the Ohio Min. Inst. Considers why Welsh coal can withstand competition and yet command a higher price; also the difficulties met in mining it. 2700 w. Mines & Min—May, 1901. No. 40695 C.

Tennessee.

Brushy Mountain Coal Mines. A. W. Evans. An illustrated description of the coal, the methods of mining and the haulage plant. 2000 w. Mines & Min—May, 1901. No. 40691 C.

Trestle Work.

Steel Trestle and Storage Pockets for Coke Ovens. Illustrated description of works erected for the New England Gas and Coke Co. 900 w. Engr, Lond—April 26, 1901. No. 40813 A.

United Kingdom.

The New Coal Question. A full supplement, with editorial, and trade opinions concerning the justice and expediency of levying an export tax on coal. 35000 w. Ir & Coal Trds Rev—April 26, 1901. No. 40817 A.

Whitehaven Collieries.

Improvements at the William Pit, Whitehaven Collieries, Cumberland. These collieries are remarkable for the large area of under-sea workings, and the long haulage. An illustrated account of changes in methods of working, and the introduction of endless rope haulage. 1200 w. Ir & Coal Trds Rev—April 19, 1901. No. 40-638 A.

COPPER.

Assaying.

See Electrical Engineering, Electro-Chemistry.

British Columbia.

The British Columbia Copper Company's Mines. E. Jacobs. Illustrations and description of some of the work done by this company. 1800 w. Eng & Min Jour—May 18, 1901. No. 41022.

Chile.

A Curious Copper Deposit in Chile. J. A. W. Murdoch. Illustrated description of a deposit in the Desert of Atacama, over 7,400 ft. above sea level. 900 w. Eng & Min Jour—May 11, 1901. No. 40894.

Deposits.

Types of Copper-Deposits in the Southern United States. J. H. Kemp. Discussion of the paper of W. H. Weed, presented at the Washington meeting. 1200 w. Trans Am Inst of Min Engs—April, 1901. No. 40828 D.

Extraction.

The Extraction Plant of the Arlington Copper Company. A. Von Zwaluwenberg. Briefly describes the method of treating the ore at Arlington, N. J. 600 w. Eng & Min Jour—May 25, 1901. No. 41225.

Germany.

Production and Consumption of Copper in Germany. Gives expert's estimates of the yield of various countries, the uses to which the product is applied in Germany, the price, etc. 700 w. U. S. Cons Repts, No. 1032—May 9, 1901. No. 40751 D.

New Caledonia.

Copper Lodes of New Caledonia. Ernest A. Weinberg. Read before the Australasian Inst. of Min. Engrs. An illustrated account of the deposits on this island of the Southern Pacific, and the mines worked. 1800 w. Aust Min Stand —March 28, 1901. Serial. 1st part. No. 40799 B.

Pneumatic Processes.

Pneumatic Processes for Leaching and Cyaniding. J. Ohly. A study of processes covered by patents, of importance in the extraction of copper and of gold because of the increased output, and the saving of time. 2300 w. Min & Sci Pr—April 27, 1901. No. 40668.

Production.

Copper Production. Editorial review of statistics of supplies for past year which show the influence of the copper combine. 1200 w. Engng—April 26, 1901. No. 40-805 A.

GOLD AND SILVER.

Abyssinia.

Gold Mining in Abyssinia. Information concerning the probability of these deposits being worked by modern methods. 1100 w. Aust Min Stand—March 21, 1901. No. 40797 B.

Africa.

The Gold-Fields of the West Coast of Africa. The article describes the conditions to be found, but gives little information concerning the deposits. 1700 w. Eng & Min Jour—May 18, 1901. No. 41027.

Alaska.

Gold Mining in Alaska. H. van F. Furman. An illustrated description of the southeastern part of the country, its formations and some of the mines. 3800 w. Mines & Min—May, 1901. No. 40689 C.

Australia.

Gold Mining and Milling in Western Australia. A. G. Charleton. Mr. Charleton's concluding paper deals with the milling and cyaniding practice at Kalgoorlie, with data as to output and cost. 5000 w. Engineering Magazine—June, 1901. No. 41193 B.

See Civil Engineering, Construction.

British Columbia.

Cadwallader Creek Mining Camp, Lillooet Mining District, British Columbia. William M. Brewer. The history, geology, development, etc., of this gold-mining camp. Ill. 2200 w. Eng & Min Jour—May 18, 1901. No. 41019.

Silver Lead. Memoranda, showing the urgent need of legislation in favor of this industry in British Columbia, presented by a deputation of mine owners to the Canadian Government. Ill. 4800 w. Can Min Rev—April 30, 1901. No. 40750 B.

The Auriferous Quartz Deposits of Southern British Columbia. J. D. Kendall. An account of these deposits, the earlier locations, some general features of the deposits, methods of promoters, etc. Ill. 7400 w. B C Min Rec—May. 1901. No. 40874 B.

Colorado.

New Life for Leadville. An account of present conditions, the great activity, new companies, gold values, etc. 2000 w. Min Inv—April 29, 1901. No. 40687.

The Cripple Creek and Leadville Mining Districts. Lecture delivered by C. J. Moore, illustrating the characteristic features of these camps. 5500 w. Min Inv —April 29, 1901. No. 40688.

Cyanide Mill.

The Dorcas Pneumatic Cyanide Mill. E. F. Gropells. Illustrated description of a custom mill constructed to treat ore from the Cripple Creek district of Colorado. Its capacity is 120 tons per day. 900 w. Min & Sci Pr—May 11, 1901. No. 40924.

Iron-Sands.

Notes on the Auriferous Iron-Sands of New Zealand. Alexander McKay. Information concerning these deposits in various districts and their workings. 8200 w. N Z Mines Rec—March 16, 1901. Serial. 1st part. No. 40795 B.

Nome.

The Placer Gold Fields of the Nome Region. Alfred H. Brooks. An illustrated account of the present condition and future possibilities of this region. 2700 w. Min & Met—May 1, 1901. No. 41009.

Placer Mining.

An Atlin Hydraulic Mine. Brief illustrated account of the mining conditions in this district of British Columbia. 800 w. Min & Sci Pr—May 11, 1901. No. 40925.

Pneumatic Process.

See Mining and Metallurgy, Copper.

Siberia.

The Gold Mining Industry of Siberia. H. L. Geissel. Describes the great gold-mining regions, and the machinery and tools in general use. 2000 w. Min & Met —May 1, 1901. No. 41010.

Smelting.

Pyritic Smelting in the Black Hills. Franklin R. Carpenter. Discussion of this paper by H. Van F. Furman. 1000 w. Trans Am Inst of Min Engs—April, 1901. No. 40822 D.

Sumatra.

Gold Mining in Sumatra. George R. Wright. Information concerning the Redjang Lebong Gold Exploitation Company. 500 w. Eng & Min Jour—May 25, 1901. No. 41227.

Vancouver Island.

Auriferous Black Sands of Vancouver Island, B. C. W. M. Brewer. An account of the difficulty met in saving the gold, and the recent success; also discusses the source. 1500 w. Eng & Min Jour—May 18, 1901. No. 41023.

IRON AND STEEL.

Acid-Steel.

The Economical Significance of High Silicon in Pig-Iron for the Acid Steel Processes. Axel Sahlin. Read before the Iron and Steel Inst. A plea for low silicon iron. 2200 w. Ir & Coal Trds Rev—May 10, 1901. No. 41047 A.

Bertrand-Thiel.

The Bertrand-Thiel Process. John W. Cabot. Observations from a recent study of the process at the works where it originated, with conclusions. 2800 w. Ir Age —May 2, 1901. No. 40659.

Bessemer Works.

A Description of the Bessemer Shop and Heating Pits at the Barrow Hematite Steel Company's Works, Barrow-in-Furness. J. M. While. Read before the Iron and Steel Inst. 2500 w. Ir & Coal Trds Rev—May 10, 1901. No. 41046 A.

Blast-Furnace Gases.

Dust in Blast-Furnace Gases. Adolphe Greiner. Read before the Iron & Steel Inst. Information of use to those using this gas in gas-engines. Also discussion. 4300 w. Ir & Coal Trds Rev—May 10, 1901. No. 41045 A.

Progress in the Application of Blast Furnace Gases to Power Generation. (Weitere Fortschritte in der Verwendung der Hochofengase zur Unmittelbaren Krafterzeugung). F. W. Lürmann. Discussing especially the purification of the gas; also describing recent large engines. A paper before the Verein Eisenhüttenleute. Two articles. 10000 w. Stahl und Eisen—May 1, 15, 1901. No. 41143 each D.

Blast Furnaces.

A Water Cooled Blast Furnace Bosh. Axel Sahlin. Illustrated description of an arrangement designed by the writer. 3000 w. Ir & Coal Trds Rev—May 10, 1901. No. 41050 A.

British Isles.

The Industrial Progress of the Cleveland District. An account of the most important iron-producing centre of the British Isles, its ironstone resources and mining, system of working, mines, &c. Ill. 3600 w. Ir & Coal Trds Rev—April 19, 1901. No. 40637 A.

Charging.

Improved Method of Operating Charging Cones of Black Furnaces Electrically (Nener Elektrischer Antrieb für Gichtglocken). A. Schwarz. A device to replace steam by electric power, for use upon furnaces in which the gas is used in gas engines for the generation of electricity. 1000 w. Stahl und Eisen—May 15, 1901. No. 41145 D.

Competition.

Britain and Her Competitors in Iron and Steel Making. E. Phillips. A discussion of the causes of the wane of British supremacy in the manufacture of iron and steel with suggested measures for checking the decline. 5000 w. Engineering Magazine—June, 1901. No. 41198 B.

Corrosion.

The Corrosion of Iron and Its Prevention. H. Carroll Alford. Briefly considers the general theory of the formation of rust, and discusses the methods of preventing or arresting corrosion. 2200 w. St Louis Ry Club—April 12, 1901. No. 40593.

Crystallography.

On the Crystallography of Iron. F. Osmond and G. Cartaud. An account of extensive experimental investigations with numerous illustrations. 6000 w. Metallographist—April, 1901. Serial. 1st part. No. 40717 E.

Exports.

The Distribution of Iron and Steel Exports in 1900. Statistics relating to the principal exports of iron and steel and manufactures of the same from the government official report. 1800 w. Ir Age —May 16, 1901. No. 40913.

Furnace.

An Improved Type of Ingot Heating Furnace. F. H. Daniels. An illustrated description of the vertical heating furnace and its method of operation, with remarks on earlier types. 1800 w. Trans Am Soc of Mech Engrs, No. 911—May 1901. No. 41099.

Hardness.

Brinell's Method for the Determination of Hardness (Brinell's Verfahren zur Hartebestimmmung). A discussion of the method of determining the hardness of steel by the area of the depression produced by a hardened steel ball under pressure in the testing machine. Two articles. 3500 w. Stahl und Eisen—April 15, May 1, 1901. No. 41142 each D.

Heat Treatment.

A Study of the Effect of Heat-Treatment on Crucible Steel Containing 1 per cent. of Carbon. George W. Sargent. Describes experiments and micro-structural investigations. Ill. 2000 w. Trans Am Inst of Min Engs—April, 1901. No. 40830 D.

Hydraulic Power.

See Mechanical Engineering Hydraulics.

Iron Sands.

See Mining and Metallurgy, Gold and Silver.

Japan.

The Steel Industry in Japan. Information in regard to the large steel works being erected by the Japanese Government. 800 w. Engng—April 19, 1901. No. 40643 A.

Metallography.

Practical Problems in the Metallography of Steel. J. O. Arnold. Discusses the use of micrographic analysis. 1400 w. Nature—April 25, 1901. No. 40686 A.

Open Hearth.

Notes on the Open Hearth Furnace (Notes sur le Four Martin). M. Clausel de Conssergues. A review of the improvements which have been made in the open-hearth furnace in the past ten years, especially with regard to capacity and economy. 3000 w. Soc Ing Civ de France—March, 1901. No. 41183 G.

"Phase-Doctrine."

Iron and Steel from the Point of View of the "Phase Doctrine." F. Osmond's remarks, and a note by H. le Chatelier accompanying a full French translation by Prof. Bakhuis Roozeboom's paper. Ill. 5300 w. Metallographist—April, 1901. No. 40718 E.

Phosphorus.

Segregation of Phosphorus in a Piece of Cold Rolled Shafting. Henry Fay. An illustrated report of an examination, microscopically and chemically, of a broken shaft showing an interesting case of segregation. 800 w. Metallographist—April, 1901. No. 40716 E.

Presidential Address.

Address of William Whitwell before the Iron and Steel Institute. Abstract. Reviews briefly the progress of the last century and discusses some of the problems awaiting solution, and other matters of interest to this industry. 4200 w. Col Guard—May 10, 1901. No. 41041 A.

Rails.

The Influence of Copper on Steel Rails and Plates. J. E. Stead and John Evans. Read before the Iron and Steel Inst. Gives results of previous investigations with report of experiments and conclusions. 2800 w. Ir & Coal Trds Rev—May 10, 1901. No. 41048 A.

Raw Materials.

The Raw Materials Used in the British Steel Industry. The present article gives information concerning the industry in the north of England. 1400 w. Ir & Coal Trds Rev—May 17, 1901. Serial. 1st part. No. 41247 A.

Researches.

Iron and Phosphorus. J. E. Stead. On investigations made of many hundreds of specimens, describing methods, and discussing results. Ill. 8500 w. Metallographist—April, 1901. Serial. 1st part. No. 40715 E.

Rod Mill.

The Passing of the Belgian Rod Mill. States the reasons for the looping type of rod mill giving way to the continuous mill. Ill. 2000 w. Ir Age—May 23, 1901. No. 41052.

Rolling Mill Practice.

A Comparison Between American and British Rolling Mill Practice. William Garrett. Read at the London meeting of the Iron and Steel Inst. A paper of great interest, blaming principally the owners and managers of British iron and steel works for the loss of British trade, and discussing points of importance. Also editorial. 1900 w. Engng—May 17, 1901. No. 40901 A.

Silicon.

Influence of Silicon upon the Strength of Cast Steel (Einfluss des Siliciums auf die Festigkeitseigenschaften des Flussstahls). E. Heyn. A report upon the experiments of Wahlberg in Sweden, as investigated at the Charlottenburg laboratory. 2000 w. Stahl und Eisen—May 1, 1901. No. 41144 D.

Steel Trust.

The Steel Trust on the Great Lakes. W. Frank McClure. An illustrated discussion of the transportation problem of the Great Lakes as affected by the steel industry. 3500 w. Rev. of Revs—May, 1901. No. 40654 C.

Titanium.

On the Influence of Titanium on the Properties of Cast Iron and Steel. Auguste J. Rossi. An account of experimental investigations and the conclusions. 5000 w. Trans Am Soc of Mech Engrs. No. 895—May, 1901. No. 41083 C.

Tropenas Process.

The Tropenas Steel Process. Edward L. Adams. Illustrated description of the installation of this process at the works of The Sargent Co., of Chicago Heights, Ill., with general remarks. 1800 w. Technograph, No. 15—1900-1901. No. 40995 D.

Urals.

The Tagil Iron District in the Urals (Der Eisenhütten bezirk Tagil im Ural). H. Tittler. A résumé prepared from the exhibits at the Paris Exposition of the Tagil district of Southern Russia, including description of mines, furnaces, and steel works. 4000 w. Stahl und Eisen—May 15, 1901. No. 41146 D.

MINING.

Drill.

The Davis "Calyx" Core-Drill. Illustrated detailed description of a rotating drill with annular cutter; also by means of the "calyx" it furnishes the chips cut from the rock in regular sequence as they are cut. 1200 w. Eng News—May 9, 1901. No. 40902.

The Fromholt Electric Diamond Drill (La Performatrice à Diamants et à Commande Electrique de M. Fromholt). M. Barbet. The tube containing the diamonds is revolved by electric power, while the pressure is given by the cooling water acting on a piston. 3000 w. Bull Soc d'Encour—April, 1901. No. 41122 G.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Explosions.

Government Tests of Maximite at Sandy Hook. An illustrated article reporting an interesting series of successful tests of a method of discharging shells charged with with a high explosive. 1300 w. Sci Am—May 25, 1901. No. 41073.

Exposition.

The Pan-American Exposition at Buffalo. I. The New York State Exhibit. Harriet C. Brown. An interesting account of the N. Y. state exhibits in the Mines Pavilion. 1700 w. Eng & Min Jour—May 18, 1901. Serial. 1st part. No. 41026.

Fans.

Rope Driven versus Direct Driven Colliery Fans. Francis T. Peacock. Read at meeting of the Canadian Min. Inst. Calls attention to the principal features to be considered in determining the type of driving, and discusses the objections and advantages of various systems. 1500 w. Eng & Min Jour—May 18, 1901. No. 41021.

Igniter.

Improved Electric Mining Igniter (Neue Dynamoelektrische Minenzundmaschine). L. Volf. A description of the Tirmann apparatus, in which the current from a portable hand-dynamo raises a platinum wire in the fuse to redness. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 27, 1901. No. 41158 B.

The New Tirmann Igniter and Delayed Shots. L. Volf, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Illustrated description of a dynamo-electric igniter and the method of working. 1200 w. Col Guard—May 3, 1901. No. 40-852 A.

Mine Entrances.

Methods of Getting Into and Out of Mines. Arthur Edwin Haynes. Illustrated review of the methods thus far used. 2000 w. Engs' Year Bk, Univ of Minn—1901. No. 40934 C.

Mine Hoist.

Flat Hoisting Cables of Aloe Fibre (L'Emploi des Cables Plats en Aloes). C. Vertongen. Giving a very elaborate study of the stresses for deep hoists and computations for cables of uniform strength. Serial. Part I. 12000 w. 3 plates. Rev Univ des Mines—April, 1901. No. 41-180 F.

The Koepe Mine Hoist (Ueber Koepe Förderungen). W. Müller. A description of an improved wire-rope hoisting system for deep mine shafts. 2000 w. 1 plate. Glückauf—March 23, 1901. No. 41152 B.

Mine Pump.

The Ehrhard and Sehmer Express Pump (Die Expresspumpe "Schleifmuhle" der Maschinen fabrik Ehrhard und Sehmer in Saarbrücken). J. Divis. An improved high-speed mining plunger pump, operating at 200-250 revolutions per minute. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 6, 1901. No. 41157 B.

Mining Plant.

See Electrical Engineering—Power Applications.

Mountain Transport.

Mining Transport Methods in the Higher Alps (Transmittel Hochalpiner Bergbane). A. Pfeffer. Illustrated description of mining railways in Tyrolese Alps. Two articles. 4500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 23, 30, 1901. No. 41155 each B.

Ore Deposits.

Problems in the Geology of Ore-Deposits. Prof. J. H. L. Vogt. Considers the original source, the relation between eruptive processes and the formation of ore-deposits, ore-solutions, etc. 15900 w. Trans Am Inst of Min Engs—April, 1901. No. 40829 D.

The Genesis of Ore-Deposits. Continued discussions of the papers of Messrs.

Van Hise, Emmons and Weed, etc., read at the Washington meeting. 7000 w. Trans Am Inst of Min Engs—April, 1901. 4 parts. No. 40825 D.

Ottoman Empire.

The Minerals of the Ottoman Empire. H. R. Jastrow. Notes some of the important minerals, and the hindrances to the development of mining. 1000 w. Eng & Min Jour—May 18, 1901. No. 41025.

Shaft Sinking.

Recent Shaft Sinking in the Ruhr District (Neuere Schachtfohrungen im Ruhrbezirk). L. Hoffmann. With details of the work of sinking shafts to depths of 450 to 1200 feet deep. 2000 w. 1 plate. Glückauf—April 27, 1901. No. 41153 B.

Smelting.

Modern Smelting Equipment. Illustrated description of the power plant, smelting furnaces, sampler and auxiliary buildings of the Granby Consolidated Mining and Smelting Co.'s copper works at Grand Forks, B. C. 1800 w. Mod Mach—May, 1901. No. 40769.

The Province of Pyritic Smelting. Herbert Lang. A reply to an editorial in this journal, wherein the ground was taken that pyritic process is not of general application. The writer thinks differently, and discusses the points brought up in the editorial. 3000 w. Eng & Min Jour—May 11, 1901. Serial. 1st part. No. 40-895.

Stamp Mills.

The Duty of Stamp Mills in Crushing and Amalgamation. Courtenay De Kalb. Read before the Can. Min. Inst. Suggestions on important points, urging the frequent and critical study of the pulp. 2500 w. Can. Min. Rev—April 30, 1901. No. 40748 B.

Tunnels.

Tunnels and Tunnel Schemes. Arthur Lakes. The advantages and disadvantages of the adit and the crosscut; circumstances where the driving of each is advisable. Ill. 3600 w. Mines & Min—May, 1901. No. 40693 C.

Veins.

Metasomatic Changes in Veins. Frank D. Adams. Also Charles R. Keyes. Discussions of the paper of W. Lindgren, read at the Washington meeting. 2000 w. Trans Am Inst of Min Engs—April, 1901. No. 40827 D.

MISCELLANY.

Chemical Reaction.

The Forecast of Chemical Reactions from the Algebraic Signs of the Quantities of Heat Liberated. H. Le Chatelier. A study of the connection existing between chemical and calorific phenomena. 2000 w. Trans Am Inst of Min Engs—April, 1901. No. 40821 D.

Diamonds.

About Diamonds. Archibald Blue, in *Canadian Mining Reports.* Some account of diamonds found around the Great Lakes and in other parts of the United States; also in South Africa. Ill. 2000 w. Min Rept—May 2, 1901. No. 40787.

Education.

English Mining Schools. E. P. Dunn. Information concerning the different schools, the objects at which they aim, etc. 4000 w. Aust Min Stand—April 11, 1901. No. 41069 C.

Egleston.

Biographical Notice of Thomas Egleston, Ph. D., L. L. D. George F. Kunz. 7500 w. Trans Am Inst of Min Engs—April, 1901. No. 40831 D.

Estimating.

Valuing a Mining Property. Arthur Lakes. Some of the difficulties are discussed. 2000 w. Mines & Min—May, 1901. No. 40698 C.

Limestones.

Michigan Limestones and Their Uses. A. C. Lane. Map showing general distribution, with outline of the uses, and related information. 2000 w. Eng & Min Jour—May 25, 1901. Serial. 1st part. No. 41226.

Magnalium.

On Alloys (Ueber Legirungen). Prof. Klandy. An address before the Oesterr. Ing. und Arch. Verein on alloys in general and the aluminum-magnesium alloys in particular. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 30, 1901. No. 40702 B.

Mining Law.

The Legal Distinction Between a Mine and a Quarry. Gives a few cases illustrating the distinction recognized by British law. 1400 w. Col Guard—April 19, 1901. No. 40641 A.

Nickel.

Notes on the Oregon Nickel Prospects. Dr. A. R. Ledoux. Read before the Can. Min. Inst. An account of these deposits, their location, type, extent, geology, etc. Ill. 2000 w. Can Min Rev—April 30, 1901. No. 40749 B.

Petroleum.

Oil Fields of California. Arthur Lakes. An illustrated description of their location, formation, the quality of the product and extent of development. 5000 w. Mines & Min—May, 1901. No. 40697 C.

The Naphtha Industry at Baku (L'Industrie du Naphte à Bakou et l'Exploitation Nobel). G. Leugny. A description of the Nobel wells and refineries at Baku, on the Black Sea. 1800 w. Revue Technique—March 25, 1901. No. 41107 D.

Russia.

The Mining and Metallurgical Industries of Southern Russia. H. L. Geissel. Illustrations of the largest blast furnaces ever built in Russia, with an account of the principal iron-producing district. 800 w. Min & Met—May 1, 1901. No. 41012.

Slimes.

Slime Treatment in the Galena-Joplin Lead and Zinc District. W. R. Crane. Illustrated description of sludge mills and the methods employed in them. 1200 w. Mines & Min—May, 1901. No. 40696 C.

Spain.

The Mineral Production of Spain. On the increase in production and development, especially of iron, coal, copper and salt. 1800 w. Engng—April 19, 1901. No. 40646 A.

Statistics.

The Mining Statistics of the World. Information from the General Report in Mines and Quarries, prepared by C. Le Neve Foster. 1400 w. Sci Am Sup—May 4, 1901. No. 40746.

Zinc.

The Zinc Deposits in Missouri, Kansas and Arkansas. An account of the production of this region, its value, and recent development. 1300 w. Min & Met—May 1, 1901. No. 41011.

Treatment of Zinc Sulphides. Describes the Ellershausen process. 900 w. Aust Min Stand—March 21, 1901. No. 40798 B.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in March. Detailed list and classified summary, with remarks. 4300 w. R R Gaz —May 3, 1901. No. 40736.

Freight.

The Conveyance of Freight on Electric Roads. A reprint of a part of an article by Alfred H. Gibbings, in *Traction and Transmission*, dealing with the problem of serving the region about Manchester, England. 1500 w. R R Gaz—May 3, 1901. No. 40734.

Inspection.

Inspection on the Manhattan Elevated Railway. A brief review giving some idea of the vigilance required to maintain such an oversight of the equipment as to prevent accidents. 1600 w. Ry Age—May 17, 1901. No. 41031.

Mileage.

Mileage: How Car Performance Can Be Improved. W. M. Prall. Considers a through car moving on a through contract, and a reorganized terminal service necessary. Also discussion. 4500 w. St. Louis Ry Club—May 10, 1901. No. 41266.

Tramways.

Tramways: Their Working and Accounts. R. S. Tresilian. On the value of accounts and statistics, with suggestions as to the form to be used. 2500 w. Tram & Ry Wld—April 11, 1901. No. 41057 A.

FINANCIAL.

Consolidations.

Industrial and Railroad Consolidations. A symposium. 1. A Great Danger to the Community. Russell Sage. 2. Their Advantage to the Public. James J. Hill. 3. Their Effects on the Steel and Iron Industry. C. M. Schwab. 4. What They Have Accomplished for Capital and Labor. Charles R. Flint. 5. Influence of the "Trusts" on Prices. F. B. Thurber. 6. The Outcome of Unintelligent Competition. James Logan. 21600 w. N Am Rev—May, 1901. No. 40752 D.

System of the United Power & Transportation Company. Considers reasons which have brought about the practice of pooling the interests of roads having no physical connection, explaining the organization, and giving the amount of capital owned by the company named, with illustrated description of some of the property. 3500 w. St Ry Jour—May 4, 1901. No. 40774 D.

Expenses.

Working Expenses of Electric and Cable Railways. Annual tables of the working expenses, receipts, etc., of the electric and cable railways of Great Britain, for which figures are available. 2800 w. Tram & Ry Wld—April 11, 1901. No. 41056 A.

Germany.

The Working Results of the Railways in Germany in 1899. Brief review of statistics concerning traffic, expenditures, etc. 1200 w. Engr, Lond—April 26, 1901. No. 40815 A.

Northern Pacific.

The Contest for Control of the Northern Pacific. A brief account of the cause of the recent collapse in the stock market. 1000 w. Ry Age—May 17, 1901. No. 41030.

Purchase.

The Southern's Absorption of the Mobile & Ohio. Information concerning the contract, with a discussion of the condition of the property, the earning capacity and related matter of interest. Ill. 2500 w. Ry Age—May 24, 1901. No. 41236.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Brake Leverage. The first of a series of articles on this subject. The present number considers see-saw, force and direction, clockwise and counter-clockwise, equilibrium, lever arm, and movements. 2500 w. Loc Engng—May, 1901. No. 40617 C.

Cars.

All-Steel Box Car, A., T., & S. F. Ry. Illustrations and brief description. 600 w. Ry & Engng Rev—May 4, 1901. No. 40755.

A New Type of Car for Steam Roads. Illustrated description of a satisfactory car for suburban traffic. The window sash is double and of much larger size than usually employed, and so arranged that the sash slides upward into the roof, entirely out of sight when it is desirable to have the car open. 1200 w. Ry & Engng Rev —May 4, 1901. No. 40757.

45-Ton Box Car of the American Car & Foundry Co. Illustrated detailed description. 1000 w. R R Gaz—May 17, 1901. No. 40953.

Railway Carriages at the Paris Exposition, 1900 (Eisenbahwagen auf der Weltausstellung in Paris 1900). H. Bernstein. An illustrated review of the exhibits at Vincennes, with plans and views of the carriages of many countries. Serial. Part I. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 3, 1901. No. 41137 B.

66-Ft. Rail Cars and 38-Ft Gondola Cars. Illustrates and describes special cars for the Cleveland, Lorain & Wheeling Ry. 2000 w. Eng News—May 9, 1901. No. 40904.

Car Lighting.

The Lighting of Railway Cars. George D. Shepardson. Reviews the various methods that have been tried and their degree of success, and gives an account of the development of the electric light for this service. 2200 w. W Elect'n—May 18, 1901. No. 41034.

Compound Engines.

Why is a Locomotive Compounded? Roger Atkinson. Explains the manner in which compounding reduces losses from cylinder condensation. 2100 w. Loc Engng—May, 1901. No. 40616 C.

Draft Gear.

Draft Gear. Clement F. Street. A letter criticizing statements and theories in a communication from H. H. Westinghouse. 1200 w. R R Gaz—May 17, 1901. No. 40951.

Electric Traction.

Electric Traction for Heavy Railway Service. Edward P. Burch. The purpose of the paper is to show the present status of electric-railway engineering and to give reasons why the electric motive power will supplant the steam locomotive for heavy railway service. 5600 w. Engs' Year Bk, Univ of Minn—1901. No. 40937 C.

Fire-Boxes.

The Fire-Boxes of Locomotives. An editorial discussion of the construction, especially the side stays. 1700 w. Engr, Lond—April 19, 1901. No. 40651 A.

Kingsland System.

The Kingsland System of Electric Traction. An illustrated description of a contact system and the working of an experimental line. 3000 w. Prac Engr—May 17, 1901. No. 41242 A.

Locomotives.

Belgian Locomotives at the Exposition of 1900 (Les Locomotives Belges à l'Exposition de 1900). F. Barbier. Detailed description with weights, dimensions, etc., of the engines shown by Belgian works at Vincennes. 3500 w. 4 plates. Rev Gen des Chemins de Fer—March, 1901. No. 41148 H.

Brooks Locomotives for the Pere Marquette. Illustrated description of a wide fire-box consolidation freight locomotive, mogul freight engine, and a passenger engine of the Chautauqua type. 700 w. R R Gaz—May 3, 1901. No. 40735.

Dickson Grand Trunk Moguls. Illustration and dimensions of large locomotives. 300 w. Loc Engng—May, 1901. No. 40614 C.

Eight-Wheel, Wide Fire-box Passenger Locomotives. Illustrated description of engines for the D., L. & W. R. R. designed for culm burning. 500 w. Am Engr & R R Jour—May, 1901. No. 40-712 C.

Eight-Wheel Passenger Locomotive, D., L. & W. R. R. Principal dimensions with illustration. 400 w. Ry & Engng Rev—April 27, 1901. No. 40613.

Electrical Locomotives. Brief illustrated description of the locomotives on the City and South London Railway. 1400 w. Elec Rev, Lond—May 3, 1901. No. 40859 A.

Fire-Throwing from Locomotives. Robert Weatherburn. A discussion of the causes such as coal, firing, blast pipe action, cylinder posts, large and small tubes, size of smoke-box, fire grate, and mechanical appliances, all of which contribute to the emission. 3000 w. Engr, Lond—April 19, 1901. No. 40648 A.

German Locomotives at the Exposition of 1900 (Les Locomotives Allemandes à l'Exposition de 1900). R. Godfernaux.

Giving detailed descriptions of the various engines, with illustrations of valve gears and parts. Serial. Part I. 5000 w. 7 plates. Rev Gen des Chemins de Fer—April, 1901. No. 41151 H.

Heavy Mogul Passenger Locomotive, N. Y., O. & W. Illustrated description of an engine for heavy service. 700 w. Ry & Engng Rev—May 18, 1901. No. 41062.

Heavy Ten-Wheel Passenger Locomotives of the Cleveland, Cincinnati, Chicago and St. Louis Railway. Engravings and dimensions of simple engines doing remarkably fine work on the road named. 600 w. R R Gaz—May 24, 1901. No. 41229.

High Speed Compound Locomotives of the Northern Railway of France (Les Locomotives Compound à Grande Vitesse du Chemins de Fer du Nord). A review of the criticisms of Von Borries of the new express engines of the Northern Railway of France. 2000 w. Génie Civil—May 4, 1901. No. 41105 D.

Krauss Locomotives. Illustrated descriptions and particulars of special types of engines. 1500 w. Engng—May 10, 1901. No. 41043 A.

New "Prairie" Type Wide Firebox Locomotives. Illustrates and describes the chief characteristics of both simple and compound types. 1000 w. Am Eng & R R Jour—May, 1901. No. 40710 C.

Observations upon the Locomotives at the Exposition of 1900 (Quelques Observations Relatives aux Locomotives à l'Exposition de 1900). With especial reference to the weight and stability of the engines exhibited. Two articles. 5000 w. Revue Technique—March 25, April 10, 1901. No. 41109 each D.

Ratios of Total Weight to Heating Surface. F. F. Gaines. A letter called out by an article in the March issue of this same publication, suggesting a comparison of heating surface and horse power, and discussing the subject. 1700 w. Am Engr & R R Jour—May, 1901. No. 40714 C.

Six-Wheel Coupled Compound Locomotive; South Italian Railways. Illustrations of a new type of high-speed compound locomotive possessing some very remarkable features. Description to be given later. 150 w. Engng—May 17, 1901. No. 41260 A.

Tank Locomotive for the Indian State Railways; Northwestern Ry., Mushkaf-Bolan Division. Brief illustrated description. 400 w. Eng News—May 23, 1901. No. 41205.

Ten-Wheel Passenger Engines; Southern Pacific Ry. Brief illustrated description, with dimensions. 700 w. Eng News—May 9, 1901. No. 40903.

Ten-Wheel Wide Fire-Box Locomotive for the Wisconsin Central Railway. Illustrated description, with dimensions, of engines burning bituminous coal. 600 w. R R Gaz—May 10, 1901. No. 40907.

The Design of a Locomotive to Make a Speed of 200 Kilometres (Bedingungen für die Banart von Dampflokomotiven für 200 km. Geschwindigkeit). E. Fränkel. A discussion of the conditions to be met in designing an express engine to make a speed of about 125 miles per hour. 1200 w. Glaser's Annalen—April 15, 1901. No. 41116 D.

The Locomotive Exhibits at the Paris Exhibition of 1900. Storm Bull. An extensively illustrated review of the locomotives, with tabulated statistics. 6000 w. Trans Am Soc of Mech Engrs, No. 910—May, 1901. No. 41098 D.

The Midland Locomotive at the Exposition (La Locomotive de la Cie. du Midland à l'Exposition de 1900). A description of the engine, together with computations of the tractive power of locomotives with single driving axles. 2000 w. Revue Technique—April 25, 1901. No. 41114 D.

The Vanderbilt Locomotive Boiler. Information concerning this design, the service of those already in use, the number under construction, etc. 3900 w. R R Gaz—May 10, 1901. No. 40908.

Multiple Unit.

Some Notes on the History and Development of the Multiple-Unit System of Train Operation. George H. Hill. 5400 w. St Ry Jour—May 4, 1901. No. 40780 D.

The Sprague Multiple Unit System. Frank J. Sprague. The object of the article is to supplement a brief operative description of the system by details of the apparatus as constructed, with comments upon features peculiar to the operation. Ill. 7000 w. St Ry Jour—May 4, 1901. No. 40779 D.

Nottingham, Eng.

The Conversion of the Nottingham Street Railways. An illustrated account of the conversion from animal to electric traction, the construction, equipment, power station, etc. 3000 w. St Ry Jour—May 4, 1901. No. 40776 D.

Repairs.

Repairs to Bent Steel Car Bodies and Trucks. Report of committee, followed by discussion. 7300 w. Cent Ry Club—April, 1901. No. 40754 C.

San Francisco.

Notes on the Market Street Railway, San Francisco. An illustrated account of the organization, operation, equipment, and management. 3800 w. St Ry Jour—May 4, 1901. No. 40775 D.

Scotland.

Glasgow Electric Tramways. An illustrated account of the opening of the Pink ston power station, with the history of the undertaking and detailed description of the system. 3700 w. Elec Engr, Lond—April 26, 1901. Serial. 1st part. No. 40800 A.

Speed Recorder.

Electrical Speed Recording Instrument. Frank B. Rae. An illustrated description of an instrument designed by the writer for recording the performance of cars on electric, steam, or other roads, and which draws a reasonably true acceleration, running, drifting and braking curve. Also valuable for other uses. 900 w. Elec Wld & Engr—April 27, 1901. No. 40603.

Staybolts.

Firebox Staybolts of Manganese Bronze (Entretoises de Foyer eu Bronze Manganésé). M. Rodrigue. Results of experiments with manganese bronze staybolts in fireboxes of locomotives of the Northern Railway of France. 2000 w. Rev Gen des Chemins de Fer—March, 1901. No. 41149 H.

Stoker.

A Mechanical Stoker for Locomotives. Illustrated description of Kincaid's automatic stoker for locomotives, and an account of a trip with it in use. 1300 w. Loc Engng—May, 1901. No. 40615 C.

Storage Battery.

Storage Battery on the Cleveland & Chagrin Falls Railway. Illustrated description of a recently installed battery in a sub-station, where it was found almost impossible to operate the road between that point and the terminus. 1400 w. St Ry Jour—May 4, 1901. No. 40777 D.

Substation.

The Cleveland & Chagrin Falls Railroad's Storage Battery Substation. R. L. Palmer. A statement of facts concerning a recent storage battery installation. Ill. 900 w. Elec Rev, N. Y.—April 27, 1901. No. 40597.

Train Heating.

Air Pumps Exhaust for Passenger Train Heating. Report of a committee of the Air-Brake Assn., presented at the Chicago meeting. 2200 w. Ry Age—May 10, 1901. No. 40881.

Trains.

Good Roads Train, Illinois Central R. R. An illustrated account of a train loaded with road-making machinery sent out to construct sample stretches of public highway between New Orleans and Chicago. 1200 w. Ry & Engng Rev—April 27, 1901. No. 40612.

Tramway Feeders.

Feeders for Electric Tramways (Stromzuführungs-Einrichtungen Elektrischer Strassenbahnen). H. Bissinger. A paper read before the Berlin Railway Association, discussing especially the arrangement of feeders for surface contact systems. 5000 w. Glaser's Annalen—May 1, 1901. No. 41118 D.

Tramway Station.

The Power House of the Union Traction Company at Anderson, Ind. Illustrated description of a 3,000-K. W. station for operating an interurban system of 163 miles; describes mainly the design of the steam power plant, but outlines the electrical plant and system of distribution to eight sub-stations. 2700 w. Eng Rec—May 25, 1901. No. 41213.

Trucks.

Bogie Trucks for Electric Railway Cars. George L. Fowler. Illustrates and describes various designs. 2400 w. R R Digest—May, 1901. Serial. 1st part. No. 40942.

The Player Patent Improved Radial Truck. Illustrates and describes the construction of trucks used under a number of recent Brooks locomotives. 1500 w. Ry Mas Mech—May, 1901. No. 40664.

Water Scoop.

A New Track Tank Water Scoop. Illustrated description of an interesting design for the N. Y. C. & H. R. R. R. 900 w. Am Engr & R R Jour—May, 1901. No. 40711 C.

Wheels.

Cast Iron Wheels Under 50-Ton Cars. Editorial discussion of the breakages of chilled cast iron wheels, and their ability for service. 1200 w. R R Gaz—May 24, 1901. No. 41231.

Chilled Cast Iron Car Wheels at Present and in the Future. William Fawcett. Concerning the severe inspection and the requirements demanded, with description of an ideal car-wheel foundry. 3000 w. Ir Age—May 16, 1901. No. 40912.

The Proper Wheel Section for Interurban Railways. Discusses the conditions of service and the difficulties due to the use of the wheels on city streets, showing the necessity of having the flanges as deep and thick as the urban roads will permit. 1200 w. St Ry Jour—May 4, 1901. No. 40778 D.

NEW PROJECTS.

Australia.

A Trans-Australian Railway. An account of a projected line connecting the extreme west with the extreme east, by a railroad nearly a thousand miles in length. 900 w. Sci Am Sup—May 11, 1901. No. 40899.

Bagdad.

The Bagdad Railway. Comment on the project known as the German Bagdad Railway, which is already under way, and the changes it will work. 1400 w. Engr, Lond—April 26, 1901. No. 40814 A.

China.

The Eastern Terminus of the Chinese Eastern Railroad. Jasper Whiting. Information concerning the southern terminus of the Chinese Eastern (Manchurian) Railroad, at Dalnie, near Port Arthur. 2000 w. R R Gaz—May 10, 1901. No. 40905.

Ecuador.

Railway Development in Ecuador. An account of very important work of railway extension now being carried to completion. 1300 w. Transport—May 10, 1901. No. 40969 A.

Paris.

Mechanical Traction in Paris. This first article explains the difficulties and conditions existing and the new policy of the Municipal Council. Also the steps taken by the Campagnie Générale des Omnibus. 3400 w. Engr, Lond—April 19, 1901. Serial. 1st part. No. 40647 A.

Thanet Tramways.

The Isle of Thanet Tramways. An illustrated detailed description. 2400 w. Elect'n, Lond—April 19, 1901. No. 40634 A.

Trans-Siberian.

The Trans-Siberian Railway. Reviews the history of this great undertaking, giving map, and tabulated summary of costs, details, and other matters of interest. 3500 w. Engng—May 3, 1901. Serial. 1st part. No. 40845 A.

Tubular Railways.

Tubular Railways. Editorial discussion of the advantages of these railways in metropolitan districts. 2200 w. Engr, Lond—May 17, 1901. No. 41253 A.

Uganda.

The Railways of Africa (Afrikanische Eisenbahnen). Col. Gerding. An address before the Berlin Railway Association, describing the progress of the Uganda railway as seen by the writer during a recent visit. 2500 w. Glaser's Annalen—May 15, 1901. No. 41119 D.

PERMANENT WAY AND BUILDINGS.

Boston Elevated.

The Boston Elevated. An illustrated description of a few features of interest in this recently opened railway system. 1100 w. St Ry Rev—May 15, 1901. No. 40960 C.

Embankments.

Some Notes on the Classification of Material and Shrinkage in Embankments. C. E. Crownover. Concerning methods used on the Union Pacific in connection with difficult work in Wyoming. 1600 w. Engs' Year Bk, Univ. of Minn.—1901. No. 40935 C.

Freight Station.

Freight Distributing Station, Chicago Terminal Transfer R. R. Illustrates and describes a receiving station conducted on a novel plan. 1000 w. Ry & Engng Rev—April 27, 1901. No. 40610.

Grades.

Grade Reduction. E. Holbrook. Discusses points in relation to the physical and business conditions which aid in determining the benefits to be derived by grade reductions. 5000 w. Ry Age—May 3, 1901. No. 40784.

Improvements.

Improvements on the Pennsylvania Railroad. An account of improvements recently made, or soon to be made, taken from the last annual report. 1200 w. R R Gaz—May 3, 1901. No. 40733.

Light Railways.

The Isle of Thanet Electric Light Railways. An illustrated sketch of lines recently opened. The station provides light, power and traction service. History and description. 4200 w. Tram & Ry Wld—April 11, 1901. No. 41055 A.

New York Central.

The Engineering Department of the New York Central. The present article deals with bridges, and track elevation. Ill. 1400 w. R R Gaz—May 17, 1901. No. 40955.

Oiled Roads.

Oil on Railroads and Wagon Roads. D. S. Harrison. Report of the manner of applying and the advantages resulting. 1400 w. Technograph, No. 15—1900-1901. No. 40997 D.

Paris.

The Tramways of the East and West Companies of Paris (Les Tramways de Penetration des Compagnies de l'Est et de l'Ouest Parisiens). H. Martin. An illustrated description of recent installations. The overhead trolley is used in the suburbs, and the Diatto contact system in Paris. 3000 w. 1 plate. Génie Civil—May 4, 1901. No. 41103 D.

Pyrenees.

The Electric Railway of Pierrefitte-Cauterets (Le Chemin de Fer de Pierrefitte-Cauterets). P. Médebielle. Illustrated description of electric railway in the Central Pyrenees, with hydro-electric power station. 3500 w. 2 plates. Rev Gen des Chemins de Fer—March, 1901. No. 41147 H.

Rail Bonds.

Bonds, Bonding and Bond Testing Methods. Albert B. Herrick. A discussion of methods and types of bonding and testing. 3300 w. St Ry Rev—May 15, 1901. No. 40957 C.

Railway Construction.

Heavy Railway Construction in Wyoming. Discussion of paper by J. I. Boggs. 1000 w. Pro Am Soc of Civ Engrs—May, 1901. No. 41271 E.

Rapid Transit.

Some Features of the New York Rapid Transit Tunnel. Illustrates the conditions at 34th St., which give eight tracks at three different levels, and calls attention to progress and interesting features. 1900 w. Sci Am—May 25, 1901. No. 41074.

Round-Houses.

Round-House Facilities. General discussion by members. 7300 w. Cent Ry Club—April, 1901. No. 40753 C.

Shops.

Locomotive and Car Shops. An illustrated description of the new shops at Fond-du-lac, for the Wisconsin Central Railway. 1500 w. Am Engr & R R Jour—May, 1901. No. 40713 C.

Signals.

Automatic Electrical Block Signal System (Selbstthätigen Elektrischen Zugdeckungseinrichtung). H. Sumpf. A description of the system of L. Jacob, of Casse, with plate showing the construction in detail. 2000 w. 1 plate. Glaser's Annalen—May 15, 1901. No. 41120 D.

Electrically Operated Railway Signals. F. J. Postel. Reviews the systems of signaling used, describing especially the applications of electricity to the operation of signals. 3000 w. Technograph, No. 15—1900-1901. No. 40998 D.

Safety Apparatus for Trains (Appareils de Securité des Trains). J. Prouteau. A description of the Primat system for furnishing an automatic rear-guard signal. 1800 w. Revue Technique—April 10, 1901. No. 41113 D.

Track circuits in Railway Signaling Plants. A. G. Shaver. Discusses briefly important points in track circuit work. 600 w. Eng News—May 16, 1901. No. 40945.

Station.

Sullivan Square Station of the Boston Elevated. Illustrated description of an unusually fine station for the use of passengers paying only five cent fares. 600 w. R R Gaz—May 3, 1901. No. 40732.

Street Shed.

A Railroad Depot Street Shed at Des Moines. Illustrated description of a 45-ft. shed for a platform, where it was necessary to have an attractive structure. 800 w. Eng Rec—May 18, 1901. No. 40964.

Terminal.

The New York Central's Boston Terminal. Brief illustrated account of proposed improvement in Boston terminal facilities. 400 w. Ry Age—May 17, 1901. No. 41032.

Track Elevation.

Track Elevation in Chicago. An account of work completed and in progress of raising 745 miles, at a cost of over $38,000,000. 1200 w. Ry Age—April 26, 1901. No. 40595.

Track Elevation in Chicago. An illustrated description of the work at the Eighteenth street section of the Chicago & Alton, Santa Fe and Illinois Central lines. 1700 w. Ry Age—May 10, 1901. No. 40880.

Tramways.

Stone Tramways. Describes a system of stone tramways development, known as the Heytor tramway, in Devonshire, Eng., opened Sept. 16, 1820, and others of similar construction. 1900 w. Engr, Lond—April 19, 1901. No. 40650 A.

Trestle Filling.

The Dale Creek Fill, Union Pacific R. R. Gives illustration and describes the methods of work. 1000 w. Ry & Engng Rev—May 4, 1901. No. 40756.

Tunnels.

The Ventilation of Elkhorn Tunnel—Norfolk & Western Railway. Charles S. Churchill. An illustrated description of the tunnel, with details of the method employed which consists of an injector and machinery for forcing the air in at one end of the tunnel. 2700 w. R R Gaz—May 10, 1901. No. 40906.

Vicksburg, Miss.

Alabama & Vicksburg Improvements in Vicksburg, Miss. Illustrated description of changes made, with explanation of the causes that led to them. 2000 w. Ry & Engng Rev—May 18, 1901. No. 41061.

TRAFFIC.

Grain Transport.

The Railways of France and the Transport of Cereals (Les Chemins de Fer Français et les Transports de Céréales). R. Bloch. A general review of the grain traffic of France and its distribution among the various railways. 5000 w. Rev Gen des Chemins de Fer—April, 1901. No. 41150 H.

Interchange.

Reports of Committees on Revision of the Rules of Interchange. Reports and general discussion. 16500 w. W Ry Club—April, 1901. No. 40971 C.

Statistics.

Railroad Statistics and Their Practical Use. A. D. Parker. Read before the Rocky Mt. Ry. Club. Also editorial criticizing some of the ideas advanced. 3600 w. Ry & Engng Rev—May 25, 1901. No. 41235.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* JOHN R. DUNLAP, PUBLISHER.

Machine Design.

The Elements of Machine Design. Part I. General Principles, Fastenings, and Transmissive Machinery. By W. Cawthorne Unwin, F. R. S. Price 7s. 6d.; pp. 555. Price, $2.50. Size, 5 by 7 in. London, New York, and Bombay; Longmans, Green & Co.

A new and revised edition of Professor Unwin's well-known treatise on machine design, more than 100 pages of new matter having been added, and some older material omitted and condensed. The present volume treats of materials of construction, methods of fastening, and the machinery of transmission. The subject of engine details is reserved for the second volume, in preparation.

Refuse Disposal.

The Economic Disposal of Towns' Refuse. By W. Francis Goodrich. Size, 6 by 9 in.; p. 340. Price, 10s. 6d.; $3.50. London: P. S. King & Son. New York: John Wiley & Sons.

An excellent review of the evolution and development of refuse-destruction, including sorting, incineration, utilisation for steam raising, and details of practice in Great Britain, America, and the Continent. Illustrations of many destructor plants are given, and data and results of operation, together with tests of steam-raising plants and general information as to costs and revenues.

Water Towers.

Towers and Tanks for Water-Works. The Theory and Practice of Their Design and Construction. By J. N. Hazlehurst. Price, $2.50. Size, 6 by 9 in.; pp. 216. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

Devoted especially to the design and proportions of iron and steel standpipes and water-tanks, discussing the materials, proportions, stability, and construction. The mechanical principles involved are explained and methods of calculation given, together with a discussion of shop practice, erection, and paint protection of the completed structure.

Steam Heating.

A Practical Treatise upon Steam Heating. Methods and Appliances for Warming Buildings, Heating Water, and Cooking by Steam. By Frederick Dye. Size, 6 by 9 in.; pp. 238. Price, $4.50. London: E. & F. N. Spon. New York: Spon & Chamberlain.

A general treatise upon heating by low-pressure, high-pressure, and exhaust steam, including the general principles of the distribution of heat in buildings, details of apparatus, and methods of computing sizes and capacity of apparatus.

Filtration.

Walter Filtration Works. By James H. Fuertes. Size, 5 by 7½ in.; pp. 280. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

A general examination of the methods of purification of public water supplies by the processes of sedimentation, and filtration, with especial reference to slow sand filtration, and of the use of rapid mechanical filters. Many examples of installations in America and Europe are illustrated and described, together with the details of operation, cleaning, and performance.

Photography.

Manuel Pratique de Photographie au Charbon. Par Edouard Belin. Size, 5 by 7 in.; pp. 87. Price, 2 francs. Paris: Gauthier-Villars.

A treatise on the method of making carbon photographic prints, with an examination of the chemistry of the process, and directions for the preparation of the paper, as well as the use of the prepared papers of commerce.

Induction Coils.

Induction Coils, How to Make, Use, and Repair Them. By H. S. Norrie (Norman H. Schneider). Second Edition, Revised and much Enlarged. Size, 5 by 6½ in.; pp. 269. Price, $1.00. New York: Spon & Chamberlain. London: E. & F. N. Spon, Limited.

Giving detailed information as to the construction of Ruhmkorff, Tesla, and medical coils, and their use in Roentgen radiography and wireless telegraphy. Practical information on the construction of primary and secondary batteries is appended, and numerous interesting experiments described.

Pocket Book.

Electric Sparks. By James A. Beaton. Size, 2½ by 5½ in.; pp. 272. Price, 75 cents. Chicago: Laird & Lee.

A handy vest pocket-book of data relating to electricity, including units, measurements, telegraphy, telephony, dynamos and motors, lighting, etc., etc.

Canal.

Report on Barge Canal from the Hudson River to the Great Lakes. Edward A. Bond, State Engineer. Size, 6 by 9 in.; pp. 1020, with portfolio of maps and profiles. Albany: James B. Lyon, State Printer.

A very valuable public document, containing a mass of information as to the proposed barge canal routes, together with tables as to rainfall, water-supply, locks and other hydraulic and hydrographic data. Much of this information has never been before published and will doubtless be of value for many other purposes than that for which it was prepared.

Commerce.

Commercial Relations of the United States with Foreign Countries during the Year 1900. Bureau of Foreign Commerce, Department of State. Size, 6 by 9 in., pp. 1231. Washington: Government Printing Office.

Volume I. of this important Government publication contains a review of the world's commerce for Africa, America, Asia, Australasia, and Polynesia, with much useful information as to the commercial practice of various countries, and very full tables of exports and imports.

Engineering Practice.

Engineering Practice and Theory. By W. H. Wakeman. Size, 5 in. by 7 in. Price, $1.00. New Haven: W. H. Wakeman.

A handbook for the instruction of all who have to do with steam engines, explaining the details of their care and practical operation, together with a series of questions to aid in the preparation for examination.

Firing.

The Practical Guide for Firemen. By W. H. Wakeman. Size, 4½ in. by 6 in.; pp. 65. Price, 50 cents. New Haven: W. H. Wakeman.

A guide for the instruction of firemen, including the daily routine, conduct in emergencies, testing, cleaning, smoke-prevention, etc.

A subject too often neglected is discussed in a practical way for practical men.

Internal Navigation.

La Navigation Internationale et ses Interests. Par Lindon W. Bates. Size, 8 in. b. 10 in.; pp. 54. Numerous plates. Paris: Imprimerie Paul Dupont.

A paper upon the harbors and canals of the world, and the best methods for their improvement, with especial reference to the hydraulic suction dredge. Presented at the VIII. International Congress of Internal Navigation, Paris 1900.

Harbor Improvement.

Concurso para la Construccion y Explotacion de un Puerto Comercial en la Ciudad del Rosario. Size, 8 in. by 12 in. Four volumes, eight portfolios of plates. Buenos Aires: Ministerio de Obras Publica.

The complete plans and specifications of the proposed works for the improvement of the harbor and port of Rosario, the shipping port of Buenos Aires. These include details of the competition and form a most valuable study of harbor improvement works, having been prepared under the supervision of Mr. Elmer E. Corthell, the well-known American engineer.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

VOL. XXI. AUGUST, 1901. No 5.

ORE-HANDLING MACHINERY ON THE AMERICAN GREAT LAKES.

By James N. Hatch.

It has been repeatedly pointed out that the United States owe their supremacy in steel making to mechanical genius rather than to physical endowments. Intensification of working, labor-saving methods, the utmost practicable development of mechanical devices for handling and transport, have more than overbalanced high wages and wide territorial separation of ores and fuel. Mr. Hatch treats the most striking features of the system for carrying the crude materials to the furnaces. Another paper now in preparation by a leading American authority on blast-furnace practice will supplement this by exhibiting the extension of similar methods within the iron works.—THE EDITORS.

THE magnitude of the iron and steel industry in the United States and its rapid and steady growth have not only kept pace with, but have been largely responsible for, the wonderful development in all other lines of advancement. Not alone in America but in all the great markets of the world American iron and steel are becoming close competitors of the foreign product. When we consider that labor is fifty to one hundred per cent. higher than in Europe, and that the distances through which the materials and product must be transported are often much greater, this condition may seem anomalous. But besides the advantages in material resources, both in fuel and ore,

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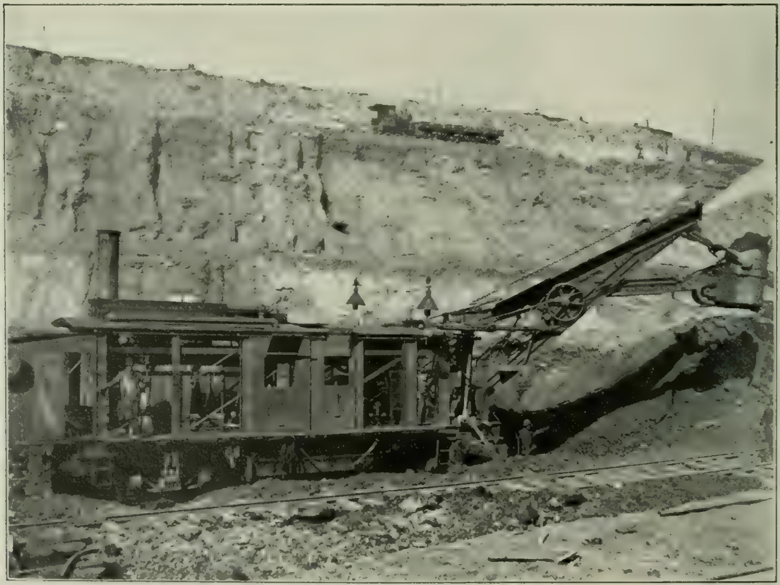
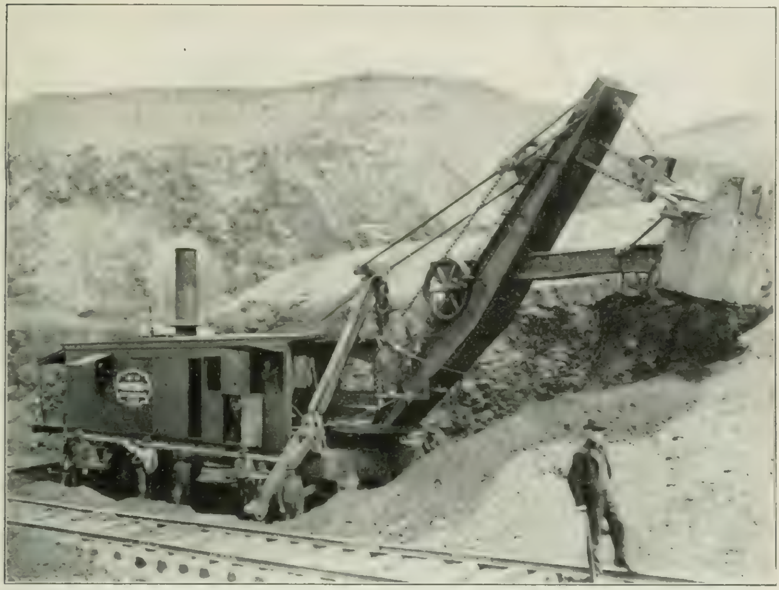
not the least among the reasons is the improved machinery used in the United States. So proficient has the Yankee become in the design of machinery for mining, loading, transporting, and unloading ore and coal that one of the chief articles of American export is this improved class of machinery.

Since the discovery of the rich ore in the Lake Superior region about fifty years ago, the problem of transportation has become much more important than previously, when the furnaces were located near the mines. The center of the iron industry had been moving westward, as the richer ores and better coal fields were discovered. But when the iron industry was almost replaced by the much greater steel industry, and it was found that the Connellsville coke was far superior to any other in the country for making steel, the attraction of this excellent coke on the one hand and of the rich bessemer ore from the lake region on the other, soon made it manifest that the center of the steel-producing region must be somewhere on a line drawn between these two points of attraction. Since it takes practically a ton of coke to a ton of ore, it might seem to make little difference at what point between these two great points of attraction the mills were located. But as a great deal of fuel is needed in the



95-TON SHOVEL HANDLING ORE FROM THE BANK TO RAILWAY CARS, MINNESOTA RANGES.
Vulcan Iron Works.

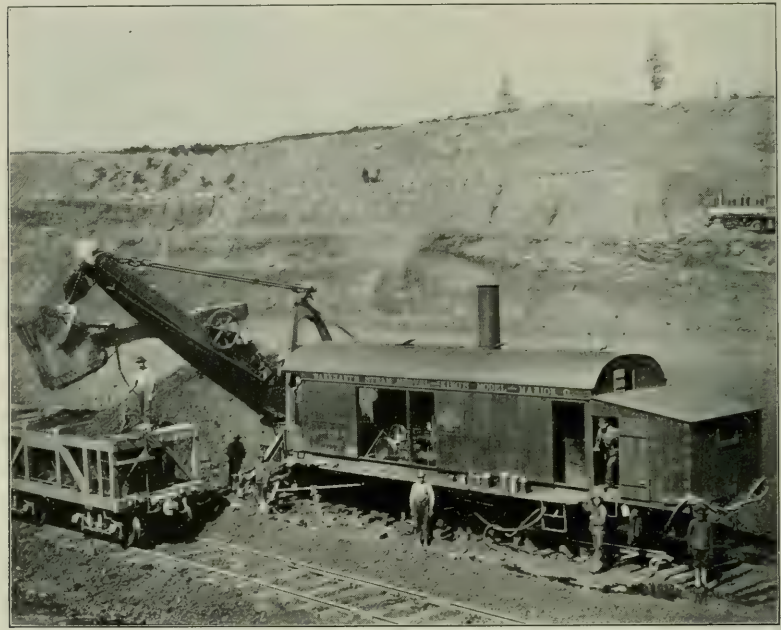


LOADING ORE FROM A MINNESOTA MINE INTO CARS FOR SHIPMENT.
Bucyrus Company's steam shovel.

mills beside the coke, it is well to be located near good coal mines. The center had for other reasons been earlier located in the Pittsburg district, and there was no good reason why it should not remain there.

The location of the furnaces settled, the problem of getting the ore to them soon began to call forth the ingenuity of many inventors. When the shipments of ore from the Superior region first began, the methods used in mining were still crude and expensive. The pick and shovel and hand drill were then the best-known implements for dislodging the ore. In deep mines the ore was lifted out of the shaft by means of derricks and horse whims; where it was possible to enter on the level, wheel-barrows and carts were employed. A plank road from the mines to the docks was constructed soon after the mines were opened, and for a number of years, wagons hauled over these roads all the ore shipped down the lakes.

Power drills driven by steam or compressed air were introduced in 1878. Tram cars were first used about 1880. In 1857 a railroad was built from Marquette to the adjacent mines. Since then the discovery of new mines, the invention of new methods of mining, and the improved hoisting machinery used at the mines, have reduced the cost to such an extent that ore that would have sold for several dollars a ton fifty years ago has of late been sold at the mines, ready for shipment, as low as 72 cents per ton. Machinery is used for almost every move the ore makes, from the time it is dislodged from the bank till it is piled up as finished steel. About 30 per cent. of the Superior ore is mined in what is known as surface mines. In this method the top soil and rock are stripped off and conveyed away, leaving the ore exposed in the form of great banks, looking much like banks of yellow or red loam. A steam shovel is then put to work against this bank that will scoop up 5½ tons to the bucketful. A train of cars is shifted along a track parallel to the one on which the steam shovel stands, and the shovel bucket is dumped into these cars.



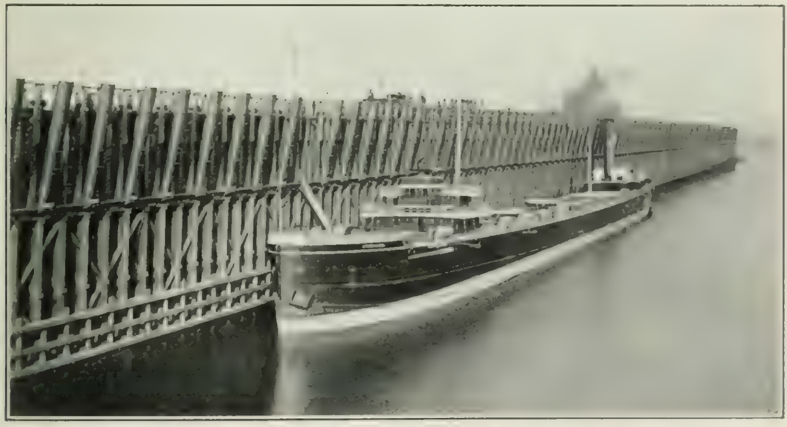
STEAM SHOVEL AT THE MINES OF THE OLIVER IRON MINING CO., MT. IRON, MINN.
Marion Steam Shovel Co.

The other 70 per cent. of ore is taken from deep mines where a shaft is sunk, often to a depth of a thousand or fifteen hundred feet. But even with these deep mines the ore can be obtained very cheaply, since close competition has forced the operator to be on the watch constantly ready to seize every possible improvement that would tend to reduce the cost of production.

The output from the Lake Superior region for the year 1900 is, as given in the table below, 18,570,315 tons. This table is interesting in showing the increase from year to year for the last fifty years. It is interesting to note the great advance in the shipment after 1855. This was the year in which the first locks at Sault Ste. Marie were finished and ready for use. Also notice, in 1861 during the war, the great falling off in lake shipments.

PRODUCTION OF IRON ORE IN THE LAKE REGION.

Year.	Tons.	Year.	Tons.	Year.	Tons.
Previous to 1854	75,083	1869	639,097	1885	2,487,446
1854	3,000	1870	859 507	1886	3,637,753
1855	1,449	1871	813,984	1887	4 729,352
1856	6,790	1872	948,533	1888	5,007,596
1857	25,646	1873	1,195,234	1889	7,588,076
1858	22,876	1874	899,834	1890	8,982,531
1859	68,632	1875	881,166	1891	7,661,587
1860	114.410	1876	993.311	1892	9,071,082
1861	49,909	1877	1,025,129	1893	6,058,955
1862	124,169	1878	1,127,583	1894	7,748,223
1863	203,655	1879	1,420,745	1895	10,429,037
1864	247,059	1880	1,962,477	1896	9,934.828
1865	193.758	1881	2.323,640	1897	12,457,002
1866	296,713	1882	2,932,953	1898	14,300,000
1867	565,504	1883	2.580,223	1899	17,901.358
1868	510.522	1884	2 321,880	1900	18,570,315



ORE PIERS AT ESCANABA, MICH., WITH ORE STEAMER LOADING.

When the only method of transporting ore from the mines to the docks was by means of wagons, four or five miles was about as far as it was practicable to bring the ore. Now it is transported over a hundred miles from the Minnesota mines to the lake ports. When these great ore trains arrive at the port they are run out on the deck and the ore dropped out through the bottom of the car into the pockets of the ore docks, whence it is afterward let out through chutes into the vessels. These docks have been constructed at an immense expense, and with these, as well as with the other labor-saving devices, every improvement possible has been made to save running expense. It is said that these docks have an aggregate length of over five miles and a storage capacity of 660,000 tons, one single dock being 2,300 feet long, with a capacity of 57,600 tons.

With the present dock equipment a vessel of 5,000 to 8,000 tons can be loaded in three or four hours. It is no uncommon occurrence to load a boat of 2,000 tons of ore in one and a half hours. The dock at Duluth cost $425,000.* Fifty years ago the ore was dumped from the wagon upon piles along the wharf. When a vessel came in to load an army of men were put to work shovelling the ore into wheelbarrows, wheeling it along plank runs out onto the vessel, and dumping it into the hold. It then required twenty men working 10 hours per day 10 days to load a vessel of 1,000 tons, at a cost of 40 cents

PENNSYLVANIA COMPANY'S COAL TRESTLE AT ERIE, PA.

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* "The ore docks of the Duluth, Missabe and Northern Company at Duluth made a record of 64,000 tons moved in twenty-four hours Monday last (June 10). This record has never been approached on the lakes, and is equal to a season's movement of 13,000,000 tons. It was taken from the docks into fourteen large boats, and the average cargo was 4,571 gross tons."

per ton. Now a vessel five times as large can be loaded in two or three hours, at so small a cost that it is hardly worth considering. Of course the interest on the investment in dock equipment must be considered, but this is more than counterbalanced by the fact that with these new methods the vessels, in which there is also an immense capital invested, are kept on the lakes almost all the time instead of lying in the harbor waiting for their load. Also twenty or thirty vessels can now be loaded in the same harbor space where one could have been loaded by the old system. It is doubtful if the new docks are much more expensive per ton of ore handled than the old ones were.

While these improvements in various lines have been put into operation, the shipping methods have not been behind in bettering their carrying facilities. A glance at the table below will give an idea of how these improvements have reduced lake freights:

Years.	Shipment.	Rates.	
		Marquette.	Escanaba.
1854	3,000		
1855	1,449		
1856	6,790	$3.00–	
1857	25,646	3.00–	
1858	22,876	2 00–$2.50	
1859	68,832	2.00– 2.50	
1860	114,410	2.00– 2.50	
1861	49,909	2.00– 3.00	
1862	124,169	2 25– 4.50	
1863	203,655	3.00– 4 00	
1864	247,059	3.00– 5.00	
1865	193,758	2.05– 5.00	
1866	296,713	2.75– 6 50	$2.50–$5.75
1867	565,504	2.00– 4.00	1.05– 3.05
1868	510,522	2.25– 3.25	1.06– 2.06
1869	639,097	2.75– 4.50	1.05– 2.05
1870	859,597	2.05– 3.25	1.65– 2.50
1871	813,984	2 05– 4 00	1.50– 2.50
1872	948,533	$2.85–$6.60	$2.00–$5.25
1873	1,195,234	3.25– 4 00	2.30– 3.00
1874	899,934	1.60– 2.50	1.30– 1.40
1875	881,166	1.30– 2.50	1.10– 1.30
1876	933,311	1.25– 2.20	.70– 1.40
1877	1,025,129	1.25– 2.00	.65– 1.50
1878	1,127,583	1.00– 1.50	.60– 1.15
1879	1,420,745	1 25– 3.00	.70– 2.10
1880	1,948,334	2.00– 2 75	1.50– 2 00
1881	2,125,729	2.00– 2.30	1.00– 1.60
1882	2,656,933	1.25– 2.00	.90– 1.40
1883	2,518,048	1.30– 1.75	.90– 1.50
1884	2,225,146	1.00	.65
1885	2,205,190	1.40	1.00
1886	3,179,511	1.75	1.35
1887	3,934,339	2.15	1.75
1888	4,113,803	1.10– 1.15	.90– 1.40
1889	5,856,169	.90– 1 25	.90– 1.25
1890	7,141,659	1 25– 1.10	1.10– 1.00

These rates are simply the toll charges from the upper lake ports to the lower lake ports, and do not include dock charges, loading, or unloading. It will be noticed that the rates in 1890 were only about —one-third the rates of 1856. After 1890 the rates fell slightly, but with the wave of prosperity they rose again to an average of about $1.00 per ton. In 1898, owing to the great increase in the carrying capacity of lake vessels, freight rates dropped to 60 cents per ton and are not likely again materially to exceed that figure.* One element

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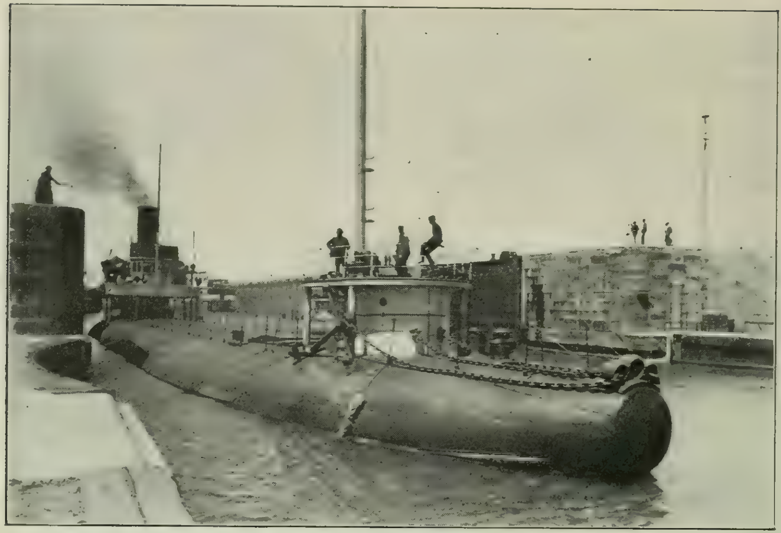
* The 20th Annual Report of the United States Geological Survey says: "It is claimed that owing to the increased draught, larger vessels, more economical engines, [illegible] loading



A WHALEBACK ORE CARRIER IN THE POE LOCK, SAULT STE. MARIE, MICH.

that has helped to lower freight rates on ore, is the rapid coal-loading devices now employed on the Lake Erie docks. A vessel that comes down the lakes loaded with ore can return loaded with coal, without a long delay to wait for her cargo.

In the last two years the sizes of lake vessels have been very materially increased. Steel vessels 500 feet in length and of over 8,000-tons burden are now being used in the ore trade to an advantage, although ten years ago it was not believed that such a vessel would ever be used on the Great Lakes.

Rapid methods of loading and very good carrying facilities had been in vogue for some years before any good method of unloading the ore from the vessels had been put into practice. And it may be said that, even now, unloading machinery is only in its infancy. However, there has been for several years machinery in use that is such an improvement over the old methods that it has really marked a new era in the ore-handling industry.

One of the pioneer machines, that proved a success, is what is known as the bridge tramway. These machines are made like a long bridge with a hinged cantilever projection, as shown in the cut. Along the lower chord of this bridge, which is twenty-five or thirty feet from the ground, is a track on which a small car or trolley runs. A bucket hangs from this trolley; this bucket can be raised or lowered

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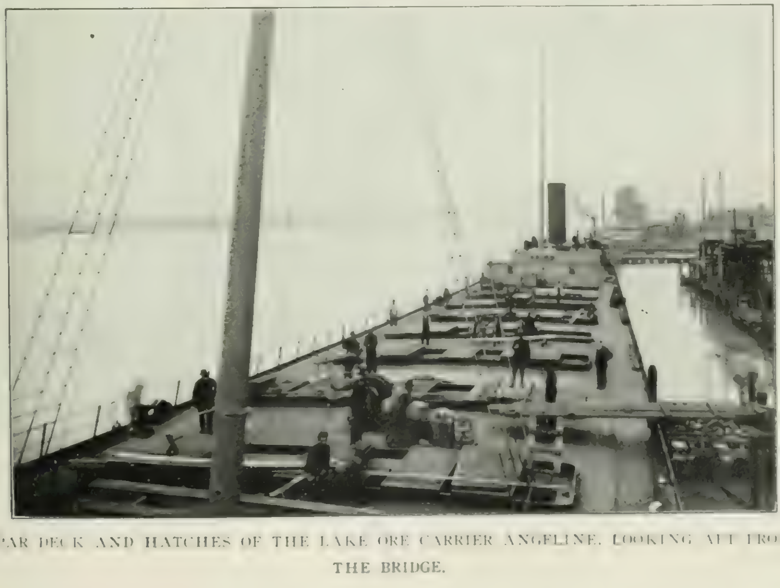
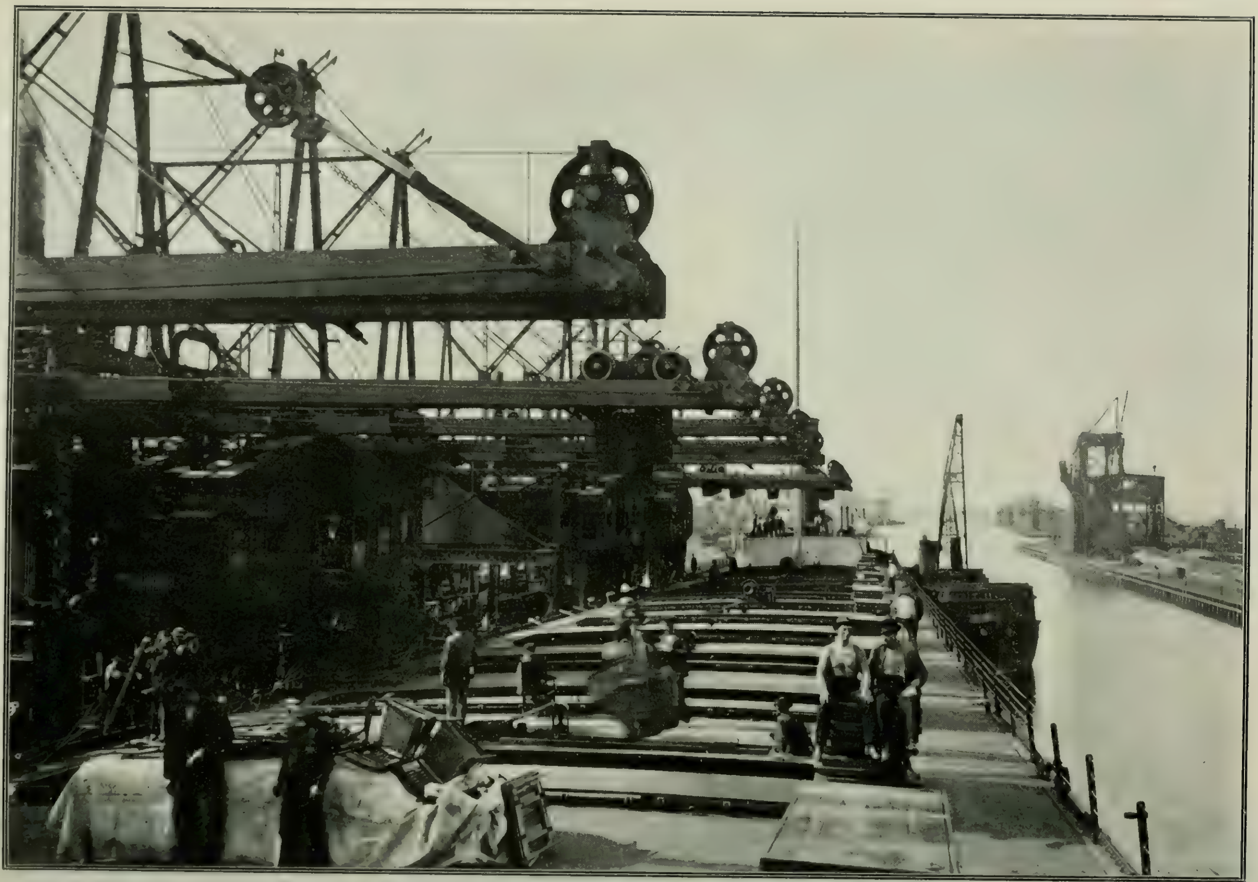
and discharging, etc., the transportation companies earn as much on the long hauls at the latter rate (60 cents) as they earned in former times on double the amount now received."

any desired distance at any point along the line of travel. The bucket used holds about a ton of ore and is filled in the vessel by men with shovels. These buckets have rollers under them, by which they can be moved about in the vessel. When a bucket is full the trolley is run out over the hold, a hook lowers and receives the bale of the bucket, the bucket is raised, and the trolley then traversed back to where it is desired to dump the ore. The load may either be dumped into cars that can be placed under the bridge, or onto stock piles three or four hundred feet from the vessel. All the operations of the machine are controlled by one man, who is located over the engine at the end of the bridge away from the dock. All these operations are very rapid, so that when everything is working properly a bucket can make a trip a minute. Several buckets can be loading at once in the hold. The large lake vessels have ten to fifteen hatches, so that at least a dozen tramways can work over one vessel. It is thus seen that 500 tons per hour can easily be handled. This would unload any ordinary vessel in one day.

The direct unloader or fast plant is similar in many respects to the bridge tramways, but is used simply for unloading into cars. It is more rapid, both in trolley operation and in movement along the dock, than the bridge tramway, but has a trolley travel of only about one hundred feet. The cut shows a set of these machines on the Conneaut dock. There are three machines operating twelve trolleys.



SPAR DECK AND HATCHES OF THE LAKE ORE CARRIER ANGELINE, LOOKING AFT FROM THE BRIDGE.

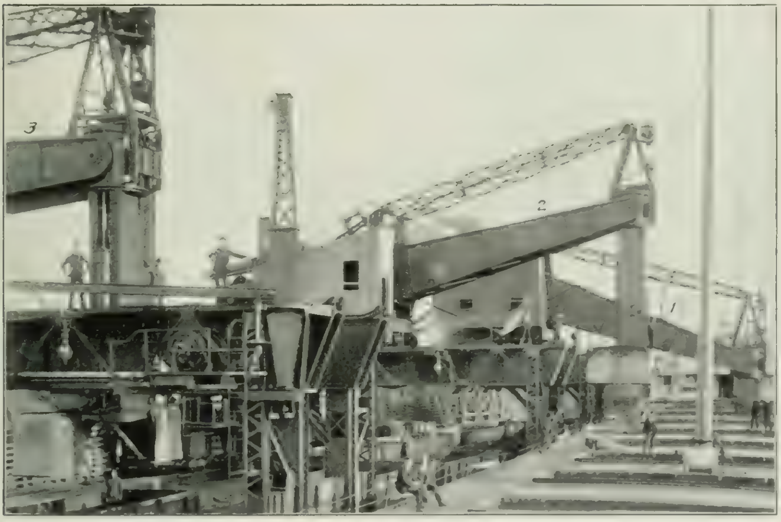


UNLOADING AN ORE VESSEL BY FAST PLANT DIRECT INTO CARS, CONNEAUT, OHIO.

Across the slip is the car-dumping plant. Beyond that, on the right bank, the Hulett unloaders. In the distance on the left the bridge tramways are seen. Brown Hoisting Machinery Co.

With these machines they have unloaded 6,000 tons of ore in ten hours. Either of the above styles of machines may be moved along the dock so as to stop over any hatch of any vessel.

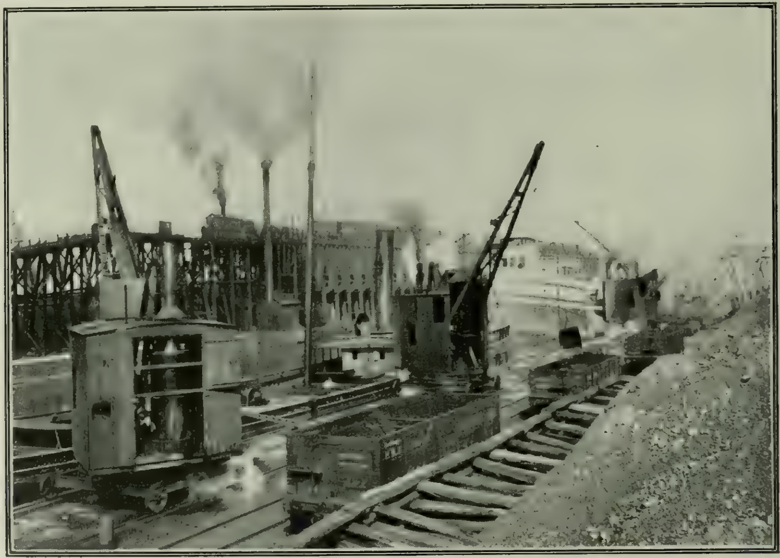
The newest unloading machine is what is known as the Hulett unloader. In the illustration there are three of these machines shown, one with the mast down in the hold of the vessel, the second with the mast withdrawn and the bucket full of ore, the third with the bucket open after having dropped the ore into the car. The bucket is of the clam-shell type. It drops upon the pile of ore in the vessel and in closing automatically scoops itself full of ore. It has a capacity of 10 tons. By means of the walking beam, the mast with the bucket attached to the bottom is lowered into the vessel. Hydraulic mechanism turns the bucket through an entire circle while down in the vessel, giving it a sweep of about nine feet, which is half the distance to the center of the next hatch. As the bucket closes it fills, and is then withdrawn and can be dumped into the cars or into conveyors which carry the ore back into stock piles. The whole machine is of steel and is of most ingenious design. It can be travelled along parallel to the dock, as it rests on wheels, on rails, and can thus stop over the hatch of any vessel. But four men are required to operate a machine. The man that controls the movement rides on the mast just over the bucket and goes into the hold with it. The capacity of a machine is about 200



HULETT UNLOADER, CONNEAUT ORE DOCKS, ON LAKE ERIE.

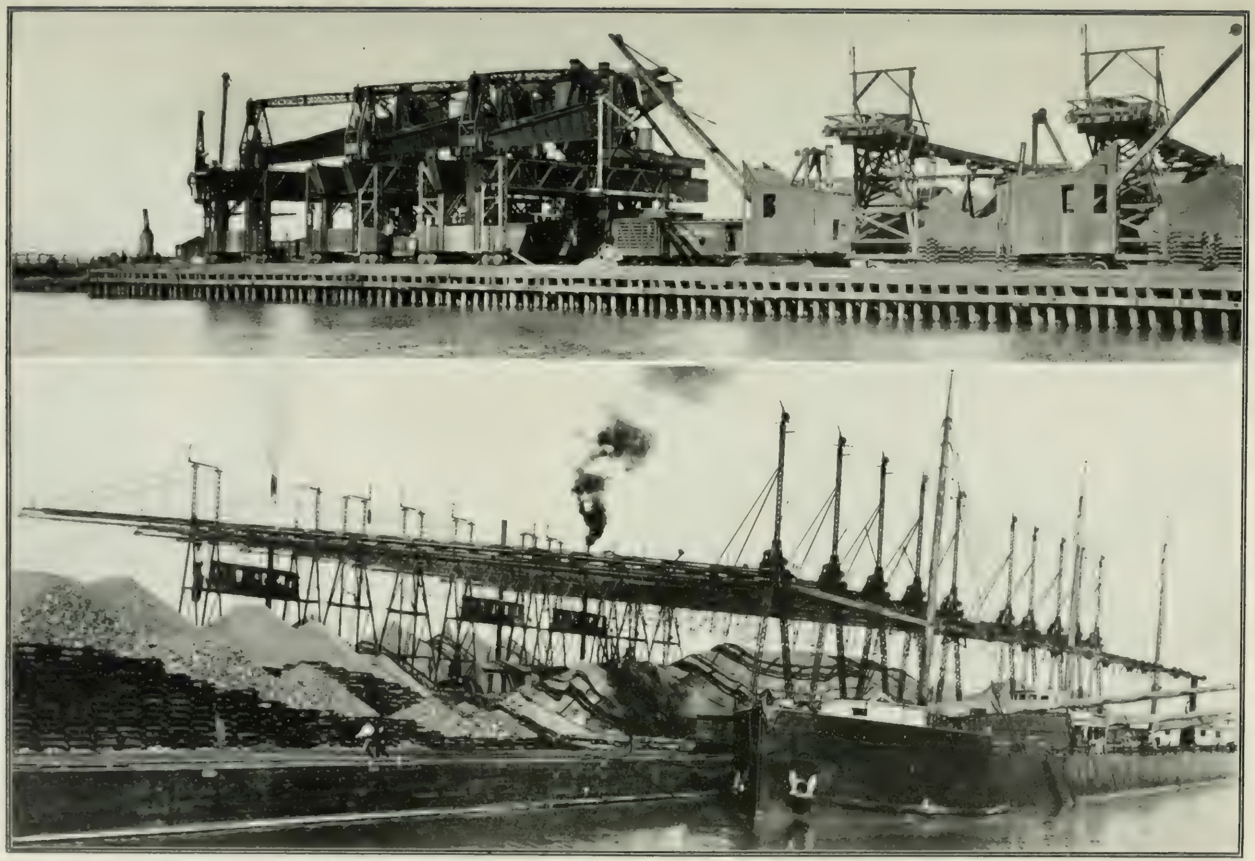
tons per hour, and it will take 90 per cent. of the ore, leaving only 10 per cent. to be shovelled. So it will be seen that four or five of these machines would unload a vessel of 6,000 or 7,000 tons in less than a day without the slightest trouble. These machines have been at work on the Conneaut docks for over a year, and while it may be said to be only in the embryonic stages of development, it is without doubt a mechanical success.

That the improvement in unloading machinery has been slower than the improvements in other branches of transportation cannot be denied, but that there is a very marked improvement is no less true. With the methods of fifty years ago, the ore was lifted out of the hold by hand, wheeled to the stock piles in barrows, and there dumped, to be again handled before it was aboard the cars ready to go inland. When a vessel tied up at the dock, although the largest vessels then would hardly carry a thousand tons, it was with the expectation of staying weeks instead of hours. For it then would have taken ten men working ten hours per day about two weeks to wheel the ore from the ship to the stock pile after it was lifted out of the hold ready to load into the barrows. And although wages were lower then than now, it would have cost about three times as much per ton to unload the boat.



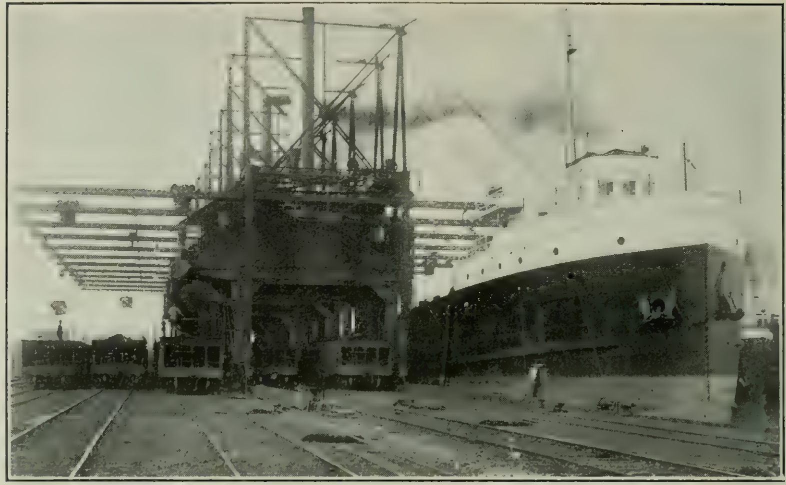
"WHIRLEYS" UNLOADING ORE ON THE ORE PIERS OF THE PENNSYLVANIA RAILROAD, ERIE, PA.

Here again is seen the great saving in wharf room, for a dozen



CHARACTERISTIC ORE-UNLOADING INSTALLATIONS AT LAKE ERIE PORTS.

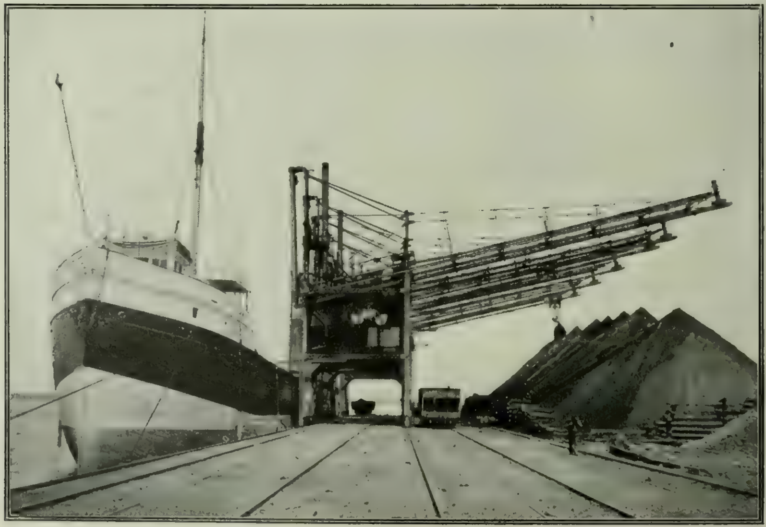
Above are shown the Hulett unloaders at Conneaut, Ohio, illustrated in a closer view on page 667. The plant below is at the docks of the L. S. & M. S. Ry., Ashtabula, Ohio, and exhibits the Brown Hoisting Machinery Co.'s bridge tramways discharging a lake ore carrier.



DIRECT UNLOADING MACHINERY ON THE CONNEAUT DOCK.

Known as the "fast plant," for discharging ore cargoes from the steamer directly into the railway cars.

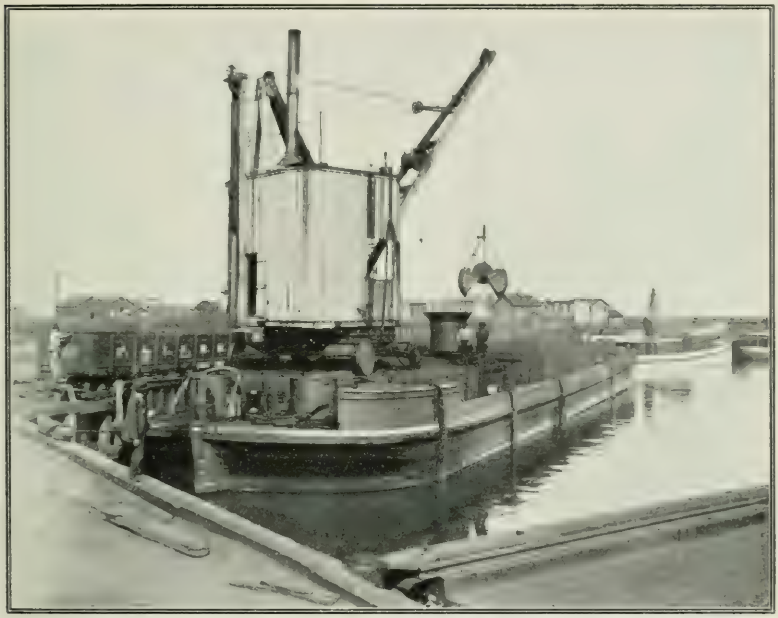
vessels can unload where one did formerly. Very recently another innovation has been introduced to avoid delay. Until within a year, after a vessel was unloaded she had to put into a coaling dock to coal for the next trip. Now there is being introduced a mammoth fueler.



HANNA'S ORE PLANT, ERIE, PA.

Brown bridge tramways discharging ore from steamer to stock pile.

This is a sort of self-propelling barge with pockets for carrying 300 tons of coal. When the ore vessel ties up and begins to unload, one of the fuelers comes alongside and transfers 200 or 250 tons of coal from its pockets into the vessel. This transfer is made by means of a crane and a two-ton bucket.



A FUELING LIGHTER WITH CLAM-SHELL HOIST, HARBOR OF ASHTABULA, OHIO.

Part of the system for rapid clearance of the lake fleets at their coaling ports.

IRON-ORE RECEIPTS AT LAKE ERIE PORTS—GROSS TONS.

PORTS	1900	1899	1898	1897	1896	1895
Toledo	645,147	792,348	414,012	416,438	301,704	260,730
Sandusky	154,542	87,499	136,200	79,792	58,667	12,361
Huron	321,914	263,600	126,755	198,231	226,515	146,442
Lorain	1,090,235	1,112,946	536,086	355,188	191,445	214,219
Cleveland	3,376,644	3,222,582	2,645,318	2,456,704	2,313,170	2,312,370
Fairport....	1,085,554	1,241,013	912,879	1,008,340	941,446	914,617
Ashtabula	3,709,486	3,341,526	2,684,563	3,001,914	2,272,822	2,474,791
Conneaut	2,556,631	2,320,696	1,404,169	495,327	327,623	244,967
Erie	1,240,715	1,309,961	1,092,364	1,311,526	847,849	811,979
Buffalo . .... Tonawanda	1,616,919	1,530,016	1,075,975	797,446	545,101	719,742
Total	15,797,787	15,222,187	11,028,321	10,120,906	8,026,432	8,112,228

The principle lower lake ports that receive iron ore, with the amount received by each, are listed in the table on the preceding page, taken from *The Iron Trade Review.*

THE HOLD OF AN ORE STEAMER ON THE AMERICAN GREAT LAKES.

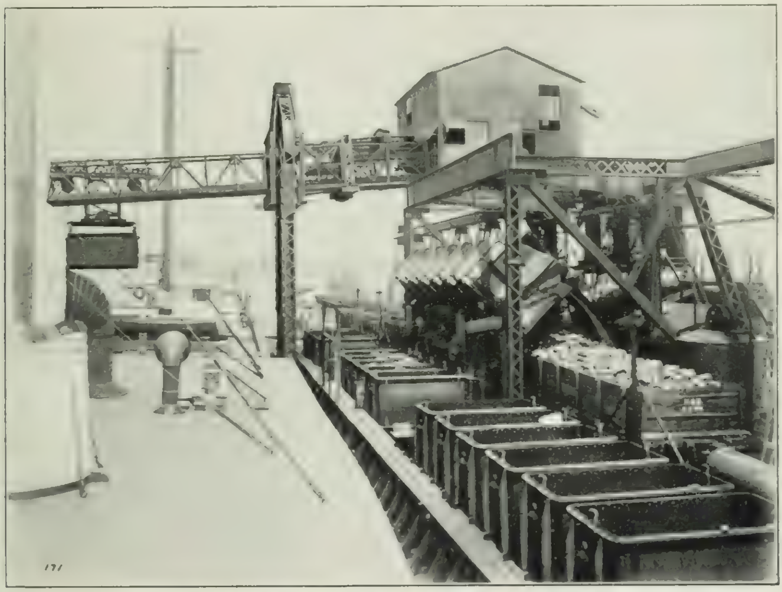
A reason why it is imperative that ore should be handled rapidly on the lakes is that the shipping season extends over about half of the year only; and for this reason also it is necessary to store an immense amount of ore in stock pile during the summer, to be distributed inland during the winter. The table given below gives the amount of ore remaining in these stock piles on December first for the past six years:

IRON ORE ON LAKE ERIE DOCK, DEC. 1—GROSS TONS

PORTS	1900	1899	1898	1897	1896	1895
Toledo........	242,375	186,422	146,568	194,644	115,959	111,132
Sandusky........	95.111	23,184	48.500	84.786	59,491	34.375
Huron	211,377	164,480	139.982	230,029	200,075	101.000
Lorain.........	251,838	337,822	324,034	317.509	231,288	224.264
Cleveland........	1,337,445	1,200,806	1,175.970	1,478,355	1,419,311	1.200,792
Fairport	611,717	692,147	719,794	825,312	773,905	605,470
Ashtabula.....	1,811,459	1,902,599	1,732,671	1,835,694	1.441,666	1,301.382
Conneaut	630,514	468,808	288,101	360,895	275.800	292.468
Erie	480.734	361,335	439,167	484,871	355,222	335.718
Buffalo........	232,100	192.681	121.620	111,660	82.267	207,199
Total.....	5.904,670	5,530,283	5,136,407	5 923.755	4.954.984	4 415.712

After the ore has been unloaded from the ships to the dock, either into the cars or upon the stock piles, in many cases it still has quite a journey to the mills where it is to be made into commercial iron. It is carried inland over two hundred miles and made into steel which, in the finished state, is again shipped west to compete with that made at the western mills.

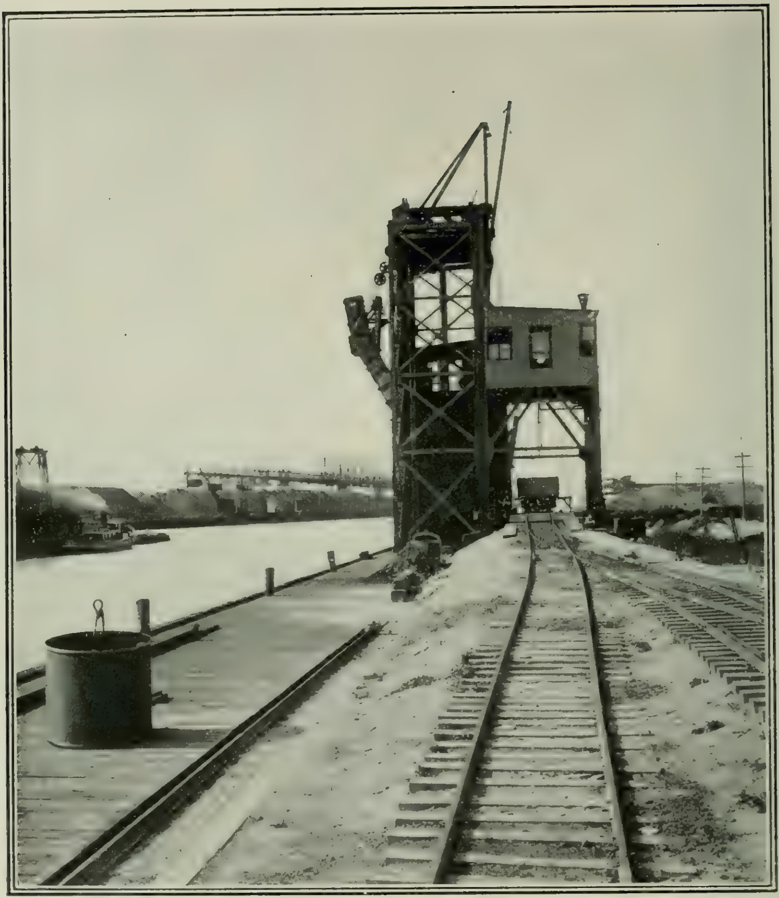
The Pittsburg and Conneaut Dock Company at Conneaut, Ohio, owned by the Carnegie Company, is one of the best-equipped docks in the country, which (it goes without saying) means is one of the best in the world. The facilities for transporting the ore by train from the docks to the furnaces at Pittsburg are unsurpassed, and the methods of unloading at the destination are well-worth noticing.



A CAR-DUMPING PLANT AT A LAKE PORT.

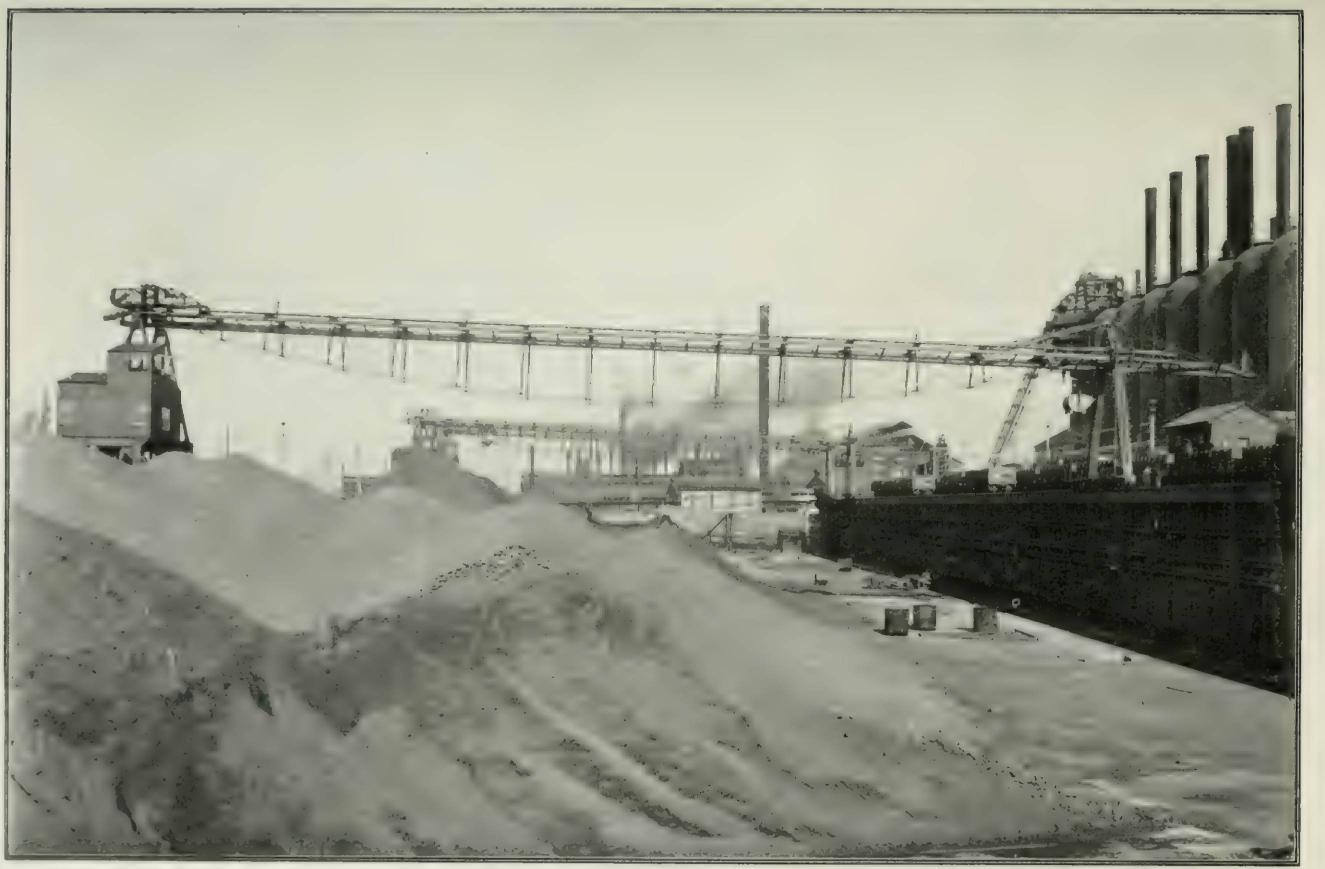
The installation shown is specially designed to place coal aboard of vessels without breakage and to trim as it loads. The railway car is picked up bodily, overturned, and emptied through the multiple hopper into the buckets, which are then taken by the crane, lowered into the hold, and emptied. The crane is moveable, serving many hatches and thus trimming the cargo it puts aboard. Brown Hoisting Machinery Co.

The Pittsburg Bessemer and Lake Erie Railway, owned by the steel company, is a new road built exclusively for the ore and coal trade. There are used some of the heaviest engines ever built, hauling a long train of immense steel gondola hopper cars holding 50 tons of ore apiece. This road forms a direct line from Conneaut to Pitts-



THE CAR-DUMPING PLANT, LOOKING ALONG THE TRACK.

burg. When these ore trains reach the Carnegie furnaces they must be unloaded as quickly as possible, to save cars and to save storage track room. The company has now in process of construction at its furnaces at Rankin, Pa., (across the river from Homestead), one of the largest car-unloading and storage plants ever built. When the loaded train comes into the yards, the cars are run one by one upon a car tipple. This machine is of Brown Hoisting Machinery type and is the largest one ever built by that company. The cars are stopped on the platform of the tipple and clamped down to the track. The tipple is then set in motion, lifting a section of the track, loaded car and all, and turning it through a vertical circle until the car is turned upside down and the 50 tons, more or less, of coal are emptied into



ORE BRIDGE AT THE CARNEGIE FURNACES.

The plant shown is the smaller one, first erected, handling 5-ton buckets. The latest installation uses 20-ton buckets. Brown Hoisting Machinery Co.

bucket cars, which stand on a track alongside the tipple and hold 22,400 pounds apiece. This machine is guaranteed to handle 300 cars in a day of 10 hours.

These bucket cars are hauled away to the side of the stock yard and stopped under the cantilever of the largest bridge tramway ever built. This tramway has a trolley travel of about 500 feet, and can pick up the bucket with its load of 22,400 pounds from the car, and carry it to any part of the yards. This load of over 10 tons can be lifted from the ground at the rate of 250 feet per minute, can be moved across the bridge at a speed of 800 to 900 feet per minute, and the whole machine, load and all, can be moved up or down the yards at a speed of 75 to 100 feet per minute. There are two of these tramways in this yard, and these are intended to handle the ore as fast as the tipple can unload it.

Every effort in every department is being exerted, and no money is being spared to render all this ore-handling apparatus the most rapid it is possible for American ingenuity to devise. And how far success has been attained may be realized from the fact that it is now possible within ten days from the time the ore is taken from the Lake Superior mines to have it for sale in Pittsburg in the form of finished steel.

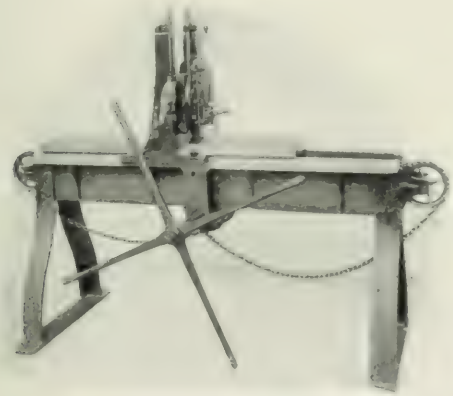
The engravings accompanying this article are for the most part from photographs supplied by the Detroit Photographic Company. For the views of the car-dumping plant and the ore bridges at the Carnegie furnaces we are indebted to the courtesy of the Brown Hoisting Machinery Company.

A PRACTICAL VIEW OF AMERICAN MACHINE-SHOP CONDITIONS.

By M. Cokely.

Unreasonable and irresponsible as labor has shown itself, it is certain that stable adjustment of relations between employer and employee can be effected only on a basis of mutual reason, of reciprocal justice and responsibility, and of common-sense recognition, by both sides, of the trend of evolution and the logic of industrial economy. If trade unionism cannot adapt itself to or if labor management will not be guided by these principles, each will fail. Collectivism, even backed by organized force, is as hopeless in the labor market as it is in the social system. Success comes through the full recognition of individual rights and free play of individual abilities.

Mr. Cokely is a specialist in the betterment of factory conditions—a close student of the factory worker. The striking feature of his argument is his clear presentation of the workman as an observing, reasoning, and generally reasonable individual. His suggestions for dealing with him as an individual rather than *en bloc* will appeal by their fairness and eminent common sense. The article is particularly timely in view of the recent violent disturbance in labor conditions in so many of the works of the United States.—The Editors.



IN considering the relations which should exist between employer and employee in industrial establishments, it is necessary to take into account their records and surroundings and the influence these exercise on character. The energy which the American workman has exhibited has not been equaled in any other part of the globe. This is true not only of the native-born but also of the naturalized foreigner. The latter soon becomes imbued with that all-pervading spirit of activity which is a recognized national American characteristic. How that spirit originated I am not prepared to explain. It may be due to race intermixture, to political or climatic conditions, or to all three; but this is positive—that the commingled races of people who have made the United States famous have emigrated to pretty much every other quarter of the earth but in no place have they developed the same characteristics or produced the same results as they have within the boundaries of the United States. Suffice it to say that this peculiarity exists and that it is nurtured by the influence of example. It is a fact that the workman has been educated to a realization of the necessity of comfort and luxury. He is a witness of it and in touch with it nearly every hour of his life. In the mansion of his next-door neighbor, in the streets and in the conveyances that traverse them, he is side by side with it. As he travels through the country he sits in the midst of it, and throughout his whole existence affluence is constantly before his eyes. He sees the man with whom, perhaps, years before, he labored side by side as a workman, now in the possession of wealth and honor. He sees no barriers to the possession of wealth and position except those due to his own natural defects. There is no class distinction in America so clearly defined as to limit his ambition or efforts. Say what one may, there is a civilizing influence in luxury, judiciously enjoyed. The example has been set for him. On the record sheet of human ambition and honorable success he may place his mark at a point equal to the highest ever reached by man. The record sheet from that exalted point down to the bottom is covered by marks, clear and distinct, of varying degrees of success according to the ambition or ability of the individual or the circumstances under which he labored. That is the record of the American workingman. Amid such surroundings and with such incentives his heart must be imbued with a spirit which lifts him above the plane of a mere servant or that of the workman as it is understood in Europe. The position which has been productive of such results cannot be otherwise than dignified, and to maintain that dignity he must receive sufficient remuneration for his labor. In describing the record of the workman we have practically described that of his employer, the manufacturer, because the majority of the manufacturers are nothing more or less than successful American workingmen—men in whom that spirit of activity was intensified to such a degree that they became the employer instead of the employed. While, as a bed-rock principle, the workman on account of his record is entitled to the highest remuneration for his service, the manufacturer is entitled to the highest possible returns from his investment. The manner in which he has benefited science by his fearless acceptance of new principles—the glory which he has secured for his country by his indefatigable efforts and the daring of his enterprise—all this and much more to his credit entitles him to every consideration and respect. But in addition to this he possesses one more virtue which shines clear and brilliant above all others; that is the generous spirit in which he reaches down and grasps the hand of the ambitious, thinking workman. There is the keynote to American industrial success. It is this spirit which has, to a great extent, nullified whatever evil there might be in the influence of over-zealous labor unions. In using the brains of his workmen to aid him, he has stimulated their inventive genius, encouraged their ambition, and inspired them with that feeling of self-reliance that brings to the surface that which is best in man.

While man's labor remains a purchasable commodity, there will always be conflicts between labor and capital, and for the person who can suggest some means by which these two elements can be brought sufficiently close together to prevent misunderstandings by viewing each other's contentions in the pure light of reason, there is no reward too great. In the pursuit of that object the employer should lead the way by managing his business in such a manner that he can afford to allow his workmen the highest remuneration for their labor. It is not a very pleasing sight, even for a workman, to see his employer's money squandered around the factory while he is "pinched" to supply it.

Looking at them as employer and employed, the manufacturer and his assistant, both animated by a spirit of justice and having in view one common ideal—that of National industrial success—let us follow them into the factory and see how it is possible to realize their ideal with the least amount of friction. The whole question of their relations hinges on the cost of production. As a result of their activity, the United States find themselves occupying a position in the industrial world to maintain which they must produce more cheaply than they have ever done before. Production has so far exceeded the requirements for home consumption that they are compelled to go into the foreign markets with their product and meet the foreign manufacturer on his own ground. Having once started in this direction they are compelled to continue or suffer an industrial depression. This is a point which should be brought home to the American workman so that he may understand the circumstances under which his employer is working and regulate his demands accordingly. As before stated, the controlling question is simply one of cheap production, and the capitalist has very wisely decided to accomplish that object by curtailing expenses at the general-expense end first. By the consolidation of business interests a much lower ratio of general expense results, consequently less necessity for reducing workmen's wages in order to meet competition successfully in foreign markets. Workers' wages should be the last thing to be touched unless they are glaringly out of proportion. Every item of general expense should be so classified as to permit of the closest scrutiny at all times in order to detect excessive waste and to determine whether changes in methods and systems cannot be effected and greater economy practiced.

The next question to receive attention is that of engineering. If the product is machinery, is the design such as will admit of the least amount of outlay in labor and material in its production? Can a cheaper grade of material be used in certain unimportant parts? Can it be arranged for a less amount of finished surface, a less number of operations, and a less amount of handling and transferring? Can it be reduced in weight? Can it be so designed as to permit of being finished on a more simple grade of machine tools? In a word, has everything possible been done in designing that machinery to permit of the lowest possible cost of production without impairing either its artistic value, its durability, or its general efficiency?

If so, then take up the question of tools, appliances, anl facilities generally. Are the machine tools such as will give the greatest possible output, or will it pay to install special tools? If the product is a specialty, has the question of small special tools, such as jigs, templates, gauges, punches, dies, and attachments, by which production is promoted, been considered? Is the best quality of tool steel used for cutting tools? Is it such a grade as will stand the highest cutting speed, or is a cheap grade in use which will stand a speed of only thirty or forty feet per minute, while a steel can be bought in the open market that will stand eighty or a hundred, and in some cases more? Has the work been classified according to the skill required to perform it, and judiciously distributed among the tools on which it can be done by the cheaper grade of labor? Has the labor been properly classified according to the skill required on the work on which it is engaged, or are we using skilled mechanics on work that should be done by handymen or boys? There is hardly anything around a factory so destructive to profits as the employment of skilled mechanics on work that requires little more than muscular effort to perform; besides, it is an injustice to a large class of workmen who, perhaps through no fault of their own, have not had an opportunity to learn a trade and become skilled. It is my firm conviction that if a man has been skilled to that pitch of perfection where he considers himself above and beyond the reach of the common laborer, he should be employed, as far as possible, only on work worthy of his skill. We can appreciate the pride, if not the judgment of the molders on this point when as a rule they refuse to operate molding machines, considering it beneath their dignity.

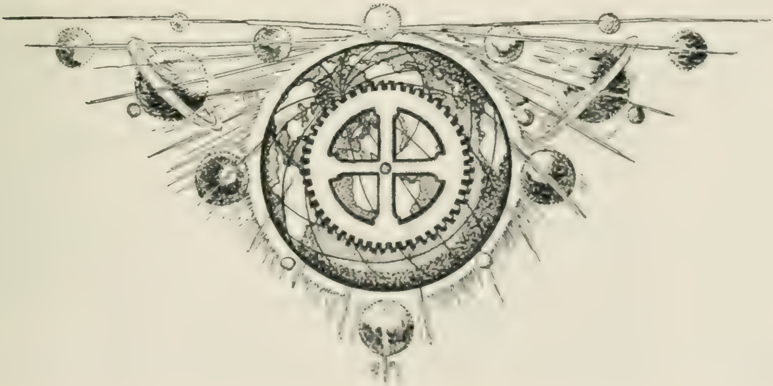
Unfortunately, the same high sense of honor does not exist among the machinists. There is no reason why a laborer should not operate a machine tool so long as the work to be done requires little or no skill. It is not the machine a man operates that makes him a mechanic, but the skill required in the work that he performs. My sympathies are with the laborer who must live and be a respectable citizen on a dollar and a half or less a day. Fortunately, through the invention of automatic and semi-automatic machinery and the standardization and specialization of product, avenues have been created through which the common laborer of thirty or forty years ago has advanced himself to a higher position in the industrial world and what is left of the place he vacated is now occupied by what is considered an element of inferior ability from continental Europe. The common laborer of old is the handy-man of today, and he is just as essential as the skilled mechanic. We can find him through most American factories doing much of the work once done by the old all-around mechanic; and with the improved facilities which he uses he is doing it not only as well, but in greater abundance, thus elevating his own position as a workman and assisting his employer to bring his product within the reach of a greater number of consumers.

There is much to be gained by a judicious distribution of the work among the tools and a proper classification and organization of the help. Their movements also should receive close attention. In walking through a shop, it takes but a glance of the practiced eye to determine the actual condition of affairs in every department and the amount that is being lost through apathy. Fortunate is the manager who from a superficial observation can detect this and see whether tools are operated to their full capacity or whether apparent activity is feigned. There is no mistaking the eager, active, animating spirit that is visible in a well-governed factory—a factory in which every man knows his duty and understands that he will be held strictly responsible for the faithful performance of it.

It is unfortunate that there should be such a lack of uniformity in the task required for a day's work. What is considered a day's work in one place is frequently but a half-a-day's work in another. This condition exists not only between different factories but often between departments of the same factory, thus producing a very bad influence on the help. While it seems impossible to improve this condition in so far as it relates to the different factories, with the more perfect organization of the manufacturers something might be done in that direction. In line with this comes the question of discipline and the observance of factory rules. Too often this refers to the shops only. No department should be exempt. Discipline, like charity, should begin at home and the office is the place to start it, as that department should serve as a model for all others. Rules of discipline should be as few as possible, but there should be a strict enforcement of those few. In some shops notices are posted at every turn notifying the help that unless they do, or do not do, so-and-so they will be immediately discharged. It is my experience that in places where notices carrying this terrifying threat are most numerous, discipline is most lax, because the threat is seldom carried out. A plain statement of what is required of employees and an example made of the first deliberate violation will be much more effective. Less threats and more dismissals will be much more beneficial, because the help will soon realize that when a rule is issued it is going to be enforced, and they will govern themselves accordingly. Discipline should not be administered so as to make men feel as though they were criminals by the enforcement of useless irritating restrictions, but rather to inspire them with a knowledge of that conduct which is necessary to the success of their employer's business.

Next in order is the prevention of waste in material, supplies, etc., and to govern this requires a knowledge of the most modern practice. What is frequently considered as waste in one factory is a source of revenue in another. Great care should be exercised not only in the purchase of material in such form, quantity, and quality as will give the most economical results, but in the final disposition of the scrap and refuse generally. In the foundry, facilities for extracting the shot from the cupola dump have been made so complete that the operation is one of the best paying features about that department, and in tests which I witnessed when the shot thus secured was melted without any mixture of pig, a very desirable grade of iron was obtained. Still we find facilities for accomplishing this in very limited use. Refuse from all other departments should receive the same close attention. The use, or rather the abuse, of supplies is often the source of considerable leakage. In fact, leaks are likely to occur anywhere along the line, both in material and labor and the best way to guard against them is to know where to look for them.

As an evidence of what can be accomplished in this direction I may cite a case in a factory with which I was recently connected. In the first department to receive attention on the lines indicated in the foregoing, after a very slight effort, and that under unfavorable circumstances, a reduction in the labor cost of the product amounting to nearly 18 per cent. was realized, without any diminution in the average earnings of the help, but rather an increase. This was in a department which was considered modern in most respects, and as it employed several hundred men, largely mechanics earning good wages, it can be seen what such a saving amounted to in a year. All other departments were treated in the same manner and a saving realized according to the condition in which they were found. The means by which the minimum cost of production can be reached are numerous and depend largely, of course, on the line of manufacture in which one is engaged; but perfect system and organization backed by good executive ability are absolutely necessary. When the employer has got his business so arranged that all sources of profit or loss are under perfect control, he will be in a position to decide whether he can afford to grant a demand for an increase of wages, or must ask for a reduction. The chances are, however, that when his business is in that condition it will not be necessary to ask for a reduction in order to meet competition, excepting during periods of extreme industrial depression. In order to avoid the necessity of a reduction, the workman should not murmur if he is requested to produce a good day's work in order to insure a good day's pay. He must remember that he is no more entitled to extraordinary remuneration than his employer is to extraordinary profits, and his co-operation is necessary to the realization of both. If he follows the inclination of his union to measure his service by European standards, he must be prepared to accept European conditions; for he can no more expect an American day's pay for a European day's work than his employer can expect an American day's work for a European day's pay—and in order to insure that advantage to his employer by which he can accord him that substantial recognition to which his record and achievements entitles him he must, in the language of the shops, "toe the mark" in line and harmony with his employer.



THE VALUE OF THE CAPACITY TEST IN BOILER-PLANT OPERATION.

By George K. Hooper.

Mr. Hooper's paper is a very interesting extension of the policy of intensified production into steam-making practice. It has direct analogy to many of the methods of works management often and ably advocated in this Magazine—methods whose purpose is to get the largest return in the shortest time per unit of investment—considering the relation of total output to total expenditure, and not economy of a single element in the scheme of production. It may be excellent economy to pay high wages for skilful workmen; it may be wise policy to drive a machine under high pressure to early destruction, for the sake of rapid production during its life; it may be, and Mr. Hooper shows that it often is, good practice in the boiler room to ignore economy per unit of fuel for the sake of securing higher economy per unit of plant. The subject affords opportunity for careful and profitable study.—The Editors.

IT has been the custom for many years, in making tests of individual boilers or of completed boiler plants, to divide the subject in hand into two parts and to make one trial to determine what fuel economy can be obtained from any given installation, and one to determine what capacity the plant is capable of developing. These are known commonly as the economy and capacity trials respectively.

To the economy test is generally given the place of greatest importance, it being felt that, since the fuel bill is so great a part of the cost of steam production, the production of steam at the least expenditure for fuel is the prime requisite of a steam generator. While within certain limits this is true, its logical conclusion is that a form of generator calculated only to this end is such a device as no manufacturer would buy nor any engineer recommend for the every-day operation of a plant.

The construction and design of steam generators, as known to us today, has varied little in the past twenty-five years so far as concerns the ability to transform the energy stored in fuel into that contained in steam at any given pressure; the tests of the generators exhibited at the centennial of 1876 compare most favorably with those of today, even if any improvement can be noticed; but on account of the demands for higher and higher pressures, the advent of new and better materials of construction, and the natural evolution of the structure, we have today in the steam generator of commercial use a structure of far greater capacity than has ever before existed. This is not necessarily because it is capable of producing a greater output per square foot of heating surface than the older types, but because it is capable of maintaining such greater output over a longer period of time with no increased risk to life and property nor unusual and unreasonable expense for maintenance.

If we can accept the above as containing even a germ of truth, it follows that the value of this capacity is worth a careful investigation, and a few examples are herewith given with a view of showing that such investigation is not unproductive of results of great value to the boiler user and interest to the boiler maker, even if they do not altogether reverse the importance which is now given to the two characteristics above mentioned and put in the place of first importance the capacity test, relegating the economy or fuel-efficiency test to the place of a curiosity only, and one to which we need pay no considerable attention.

There enters the discussion at this point a chance for an honest difference of opinion, since an able engineer of large experience has told us that he has found that the fuel efficiency of steam generators increases with their capacity, and considerable weight attaches to his results. It is a generally accepted fact, however, that his experience, although perhaps none the less actual, possessed certain unique features, since from time out of mind the capacity tests of such apparatus have shown a decreased fuel efficiency and higher evaporative rate than the apparatus exhibited at the point at which the maximum evaporation per unit of fuel had been developed. It is my opinion that the burden of evidence lies with the latter state of affairs, although I am prepared to accept the former within certain limits.

To the steam user, the various items which go to make up the cost of the steam produced in his plant are as follows: cost of fuel, cost of labor, rent or first cost of land, cost of buildings, draft, water, and superintendence, and all of the above possess a definite value. This value varies according to locations and ideas, but is always present and must be reckoned with. That the values may not be comparable between two given plants is very likely true, but that that fact has little bearing on the ultimate truth of the discussion is also true; it is necessary only to remember that they are present in some form and are straws showing which way the wind blows.

The fixed charges on the investments represented in the following examples will therefore be figured at 10 per cent. per annum for interest on the money invested and at 10 per cent. per annum for the book depreciation.

The first example is that of a boiler plant in the middle western States using natural draft and being hand fired. The generators are in two units, and contain 3,750 square feet of heating surface each, the plant installed complete representing an investment of $15,558.20. The fuel is of a rather low grade and cost $1.31 per short ton in front of the boilers, while stokers' labor is worth $1.65 per 10-hour day per man. The cost of the fuel used includes the amount necessary for banking at night. The tests cover a period of ten hours each under actual running conditions, and the highest fuel efficiency developed was 68 per cent., which corresponds to an evaporation of 7.882 pounds of water from and at 212° F. per pound of dry coal. The generators under this condition evaporated 3.23 pounds of water per square foot of heating surface per hour from and at 212° F., making the cost of 1,000 pounds of steam the following:—Fixed charges per day, $10.04; amount of steam produced, $7,500 \times 3.23 \times 10 = 242,250$ pounds; coal used $(242,250 \div 7.882 + 2,310$ pounds for banking $=$ 30,734.6 pounds, which at $1.31 per ton represents $21.65. There were two stokers required to handle this fuel, which makes a labor cost of $3.30, while to bring the necessary feed water to the generators cost $1.20. The schedule is as follows:

Fixed charges	$10.04
Fuel	21.65
Labor	3.30
Water	1.20
Total	$36.19

and since 242,250 pounds of steam were produced, the cost to produce 1,000 pounds is obviously $\$36.19 \div (242,250 \div 1,000) = 14.939$ cents.

In the second instance the same plant was operated at an evaporative rate of 4.206 pounds of water per square foot of heating surface per hour from and at 212° F., an increase of 30.21 + per cent. over the first instance, the evaporation per pound of dry fuel dropping to 7.333 pounds water from and at 212° F., which corresponds to a fuel efficiency of 63.27 per cent., or 4.73 per cent. less than before. At this rate the plant produced $7,500 \times 4.206 \times 10 =$ 315,450 pounds of steam, consuming in doing so $(315,450 \div 7.333) +$ 2,310 pounds banking fuel $= 45,326$ pounds of fuel, representing at $1.31 per ton a value of $29.69. The labor of two firemen was required in handling this fuel, giving a labor cost of $3.30 as before.

To bring the increased amount of water to the plant involved a cost of $1.56. The schedule is as follows:

Fixed charges	$10.04
Fuel	29.69
Labor	3.30
Water	1.56
Total	$44.59

and since 315,540 pounds steam were produced, the cost per 1,000 pounds is obviously $44.59 ÷ (315,450 ÷ 1,000) = 14.132 cents, or but 94.59 + per cent. of our cost at point of highest fuel efficiency, the output, it will be remembered, being 30.21 + per cent. greater.

In the third instance the same plant evaporated 5.33 pounds of water per square foot of heating surface per hour, or an increase of 65.01 + per cent. over the capacity at point of highest fuel efficiency, the evaporation per pound of dry fuel dropping to 7.21 pounds of water from and at 212° F., which corresponds to a fuel efficiency of 62.21 per cent., this being 5.79 per cent. less than the highest found. At this rate the plant produced 7,500 × 5.33 × 10 = 399,750 pounds steam, consuming in so doing (399,750 ÷ 7.21) + 2,310 pounds banking fuel = 57,753 pounds, which represents at $1.31 per ton a value of $37.83. An extra fireman was required in the handling of this greater amount of fuel, increasing the labor cost by 50 per cent., without, however, any disastrous results on the ultimate cost as the following schedule will show, an increased expense for water being also entailed:

Fixed charges	$10.04
Fuel	37.83
Labor	4.95
Water	1.98
Total	$54.80

and since 399,750 pounds steam was produced, the cost per 1,000 pounds is obviously $54.80 ÷ (399,750 ÷ 1,000) = 13.709 cents which is but 91.77 per cent. of the cost at point of maximum fuel efficiency, although the output is 65.01 per cent. greater.

The second case will deal with a plant under widely different conditions as to cost of fuel and labor. It is located on the sea coast, and consists of vertical fire-tubular boilers set in considerably larger battery, although each unit is small, containing but 2,500 square feet of heating surface. Since but one boiler was tested the results will be calculated for but one boiler. The plant is hand-fired at a cost of $2 per day per stoker, and the draft was furnished by a chimney, hence known as "natural." Fuel was worth $3.60 per ton in front of the boilers. The cost represented by one unit of the plant in operating condition is \$5,786.20, which gives a daily fixed charge on the basis explained above of \$3.73.

Out of a considerable number of tests, that representing maximum fuel efficiency shows an evaporative rate of 2.48 pounds of water per square foot of heating surface per hour from and at 212° F., the evaporation per pound of dry fuel under the same temperature conditions being 11.09 pounds. This corresponds to a fuel efficiency of about 71.42 per cent., the indecision arising from the fact that no fuel analysis was given of the fuel so that an average of heat values from reputable calorimeter tests was adopted as a basis. The amount of steam produced was $2{,}500 \times 2.48 \times 10 = 62{,}000$ pounds, in the production of which was consumed $(62{,}000 \div 11.09) + 662$ pounds banking fuel $= 6252.6$ pounds, representing a value at \$3.60 per short ton of \$11.26. The labor of one stoker was used in handling this fuel, involving an expense of \$2 for labor, although it is clear that the proportion of labor is very high. No expense was involved in bringing water to the plant. The schedule is as follows,—

Fixed charges	\$ 3.73
Fuel	11.26
Labor	2.00
Total	\$16.99

making the cost per 1,000 pounds of steam \$16.99 ÷ (62,000 ÷ 1,000) = 27.403 cents.

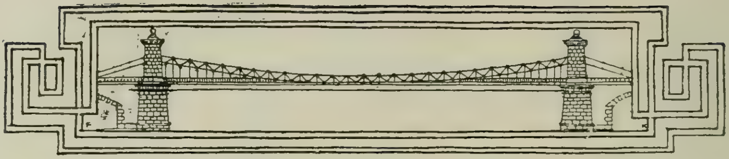
The second instance under this case shows the maximum capacity reached at an evaporation of 4.9 pounds of water per square foot of heating surface per hour from and at 212° F., the evaporation per pound of dry fuel dropping to 9.61 pounds of water under the same temperature conditions, which corresponds to a fuel efficiency of 61.88 + per cent., or 9.54 per cent. less than the maximum. Under these conditions the generator produced $2{,}500 \times 4.9 \times 10 = 122{,}500$ pounds of steam, at a consumption of $(122{,}500 \div 9.61) + 662$ pounds banking fuel $= 13{,}409$ pounds coal, representing a value at \$3.60 per ton of \$24.14. The schedule is as follows,—

Fixed charges	\$ 3.73
Fuel	24.14
Labor	2 00
Total	\$29.87

There was no increase in the labor cost over the first instance, although the percentage of labor cost to the whole is yet higher than necessary. Since 122,500 pounds steam was produced, the cost per 1,000 pounds is obviously \$29.87 ÷ (122,500 ÷ 1,000) = 24.39 cents, which is but 89 per cent. of the cost at point of maximum fuel efficiency, although the quantity produced is 75 per cent. greater.

As a *résumé*:—The maximum capacity test in Case I. shows that it is possible in that plant to make steam for 91.77 per cent. of the cost at point of highest fuel efficiency, by increasing the evaporative rate and therefore the capacity of the plant to 165.01 per cent. of the capacity at that point, or to 153.16 per cent. of the commonly accepted rate on which the capacity of steam generators is founded; and in Case II that it is possible to make steam at but 89 per cent. of the cost at point of highest fuel efficiency, by increasing the evaporative rate and therefore the capacity to 175 per cent. of that rate at which maximum fuel efficiency is found, or to 140.8 + per cent. of the commonly accepted rate on which the capacity of steam generators is founded, even though the fuel consumption is increased by 9.3 per cent. in the first case and by 15.41 per cent. in the second.

At this point, without making this article cumbersome by giving the results of many other tests which have been figured over with similar results, I will rest my case in favor of the capacity trial. It has been made apparent that in not giving it careful study much opportunity for cheapening the cost of steam, whether for power or other uses, is neglected, since in the present use of steam generators, whether or not we consider the use of automatic furnaces, the limit of fuel efficiency has remained about the same for many years. That some of the present makes of steam generators are capable of maintaining high evaporative rates over an indefinite period is an indisputable fact, and the figures deduced above show that much more may be gained by changing design and construction to give increased strength and capacity than by cutting down first cost to maintain present maximum fuel efficiency. The field in this direction is no narrow one, since, if we accept the above figures as containing truth, a buyer will gladly pay 50 per cent. over present market rates for a generator to maintain such larger capacity, and one which shall at the same time cut down his operating costs by the percentages shown. It will be apparent to the thoughtful reader that the rate at which fixed charges are estimated may vary between wide limits without having appreciable effect on the result, the fact that such charges must always be present being of course an accepted one. It is also apparent that, should the fuel efficiency increase as the evaporative rate increases up to or beyond the points shown in the above examples, the case for the capacity test is made even more favorable.



THE AMERICAN LOCOMOTIVE AS A HIGH-SPEED MACHINE.

By Egbert P. Watson.

Mr. Watson's paper has especial value on account of the recent revival of interest in the working of American locomotives on British railways. The latter topic was ably discussed by Mr. Rous-Marten in THE ENGINEERING MAGAZINE for March last. Mr. Watson makes hardly any immediate reference to the controversy, but yet contributes valuably to its reasonable settlement by pointing out the fact that the whole problem is larger than can be encompassed in the measure of a few semi-experimental figures. The American locomotive does its work under conditions relatively much more difficult and trying than those imposed on the British engine, and does it well, from both mechanical and financial standpoints. The proof of its performance is in American railway rates and dividends. And Mr. Watson is in accord with the best American railway managers in maintaining that the proper place to begin the movement for faster running is not with the machine, but with the track over which it runs. —THE EDITORS.

RECKONING in round numbers, the distance from New York to Washington, D. C., is about two hundred and fifty miles; it is the same to Boston, Mass.; to New Haven it is seventy-two miles, and to Philadelphia ninety miles; but the average speed attained during the runs between these cities does not exceed forty miles per hour except upon a few special trains. In many cases the average speed is less than forty miles. An express leaves the Grand Central Station in New York City at 9:05 a. m. and arrives at New Haven two hours later, average speed thirty-six miles per hour, making but two stops in the run. The Pennsylvania Railroad and the Central Railroad of New Jersey run trains between New York and Philadelphia which require two hours to make the ninety miles, with but one stop scheduled, but with ferriage of ten to twelve minutes across the Hudson river included in the two hours' running time; the Royal Blue Limited, of the Central Railroad of New Jersey, makes the run to Philadelphia in two hours and three minutes, and the run to Washington in five hours, schedule time, and these are the best trains in service, there being many others making more stops and having more coaches attached which are slower. The best and swiftest trains carry but few passengers, say two hundred and fifty when fully loaded, and it still requires a whole business day, twelve hours or more, to go from Boston to Washington, and this only when all connections are made promptly. There are, as is well known to travelers, several very fast special trains run upon some of the trunk lines—the fast express to Atlantic City, or the Empire State express which attains an average speed exceeding fifty-three miles per hour on a run of four hundred and thirty-nine miles from New York to Buffalo; but they run but once daily in each direction and cannot be said to be widely available to the general public, by reason of their limited accommodations.

The average speed on the railways of the United States is not markedly higher today than it was twenty-five years ago, between the principal cities of the Union, for at the period mentioned it required only six hours to go two hundred and fifty miles upon express trains, and that is the time required now. It is not asserted that the managers of railways are indifferent to this state of affairs, and do not desire to make better time; the contrary is true, and they have done what they could in certain directions to cut down the time between important terminals by straightening curves, reducing grades where possible, employing more powerful engines, and laying heavier rails, but the gains in time are slight in comparison with the public demand.

Careful consideration of the subject under discussion—higher speed upon railways—leads to the belief that it will not be attained for some years to come unless there is a radical change in the permanent way itself, and I am of opinion that therein is the chief obstacle. All the railways in the United States pass through the lines of least resistance, except where detours are purposely made to include certain districts where large amounts of profitable business can be had. The right-of-way in thickly settled portions is expensive, and if it is less costly to go three or more miles in an indirect line to avoid serious outlays or natural obstacles, the crooked route has in the vast majority of instances been laid out.

Now the earning capacity of a railway depends, all other things being equal, upon the hauling power of its locomotives under the most favorable conditions, that is, upon the cost per train mile; and it follows as a corollary that when the conditions are unfavorable the railway suffers loss. For the purposes of comparison it does not matter in this consideration whether the immediate fault is in the rolling stock or in the line itself; the first can be remedied by procuring better cars, but the last postulate is a much more serious one. The topography of certain lines forbids high speeds; nevertheless fast running is attempted upon them, and there is a constant struggle, day by day, to endeavor to overcome natural obstacles by mechanical expedients, and the natural obstacles always win. Consider the case of a trunk-line railway following a tortuous water-way for long distances, directly upon the foreshore. Heavy trains, consisting of so many cars that the whole train is often upon reverse curves, are run at the highest speed possible, but with great loss of time and power, and this not for short distances, but for hundreds of miles on several different lines. It is not a matter for wonder that the average speed is low; it is astonishing that it is not less. For, while it is true that the locomotive of today is a far more powerful machine than it was twenty, or even ten, years ago, it must be borne in mind that the load and duty imposed upon the modern engine have been largely increased. This is one reason why the average speed is still less than forty miles per hour.

Some writers have urged the adoption of new types of locomotives with a view to obtain better service, but it would seem impossible, or if that is too strong a term, impracticable, to gain anything in this direction within any reasonable limit of time, for the simple reason that a radically new locomotive would be very slow in coming into practical use, and while it was being perfected and experimented with the traveling public would be no better off than it is at present. The locomotives in use on all the railways of the United States are of similar types in their several classes, such and such classes for speed and such others for hauling loads. They differ but in matter of details and proportions, and these moot points, so to call them, have been evolved only after long years of trial and error. If we are to throw all this experience away, and fly to other machines of which nothing is known, save that they "work" mechanically, or will apparently haul trains, we "take up arms against a sea of troubles" and for a certain period at least will fight losing battles. This is not a mere assertion or a prediction to sustain an argument; it is based upon the experiences of the past few years. The "new locomotive" projector is always with us, and it must be conceded that he is a daring spirit generally possessed of the courage of his convictions.

Within ten years last past two "friction-geared" locomotives have been designed which were to settle the question of high speed affirmatively upon their first trials. It could not be shown to either of the inventors that his scheme was radically wrong in all directions, especially as regarded mechanical principles; they cared nothing for the latter, intending to overcome such difficulties by an "appliance"; nothing would satisfy them that the rest of the world were right and they were wrong except costly experiments, requiring full-size engines built upon their plans and put to actual use in hauling trains. This was done with results which had been predicted, but the inventors doubtless feel to this day that they did not have a fair chance. The two locomotives just mentioned came under the head of freak engines, for they were monstrosities in design and construction, unlike anything ever seen before upon railway lines, but still another new locomotive was built during the past decade which was intended to be a radical improvement over existing engines. It was planned by an engineer of ability, who conceived it to be his mission to solve the question of hauling heavy trains at high speed by certain modifications in the present locomotive. It was by no means a freak engine, but it contained several innovations which led to its rejection by railway officials. Among these departures was a corrugated, cylindrical, duplex fire-box, there being two furnaces joined like the letter Y, leading into a common combustion chamber. The junction of the branches of the Y with the combustion chamber gave constant trouble by leakage, and the valve-gear was also in dispute as to its reliability, it being a modified link-motion with the intention of securing better steam distribution. This locomotive was tried in various parts of the United States on different railway systems, but it was never adopted upon any of them, and certainly was not discarded from prejudice; it was simply tried upon its merits. Innovations are not themselves objected to, for they are constantly experimented with by railways all over the land; frequently they are designed by the officers of the motive-power departments and pronounced good, until, sooner or later, they develop weaknesses which render it impossible to maintain them and they are promptly thrown out, even after they have been put upon many engines.

The points of my argument as to the further development of the American locomotive as a high-speed and high-power machine are these: That a radically new locomotive is not available for immediate service; that railway officials will give promising devices fair trials; and, lastly, that the field for radical improvement is exceedingly limited. Step by step the present engine has been raised from 500 horse power to 1,500 horse power and more in some cases, but not by means of startling novelties of any kind. The chief improvement has been secured through increasing the boiler power from 150 pounds per square inch, which was a maximum fifteen years ago, to 200 pounds as a rule and 225 pounds per square inch in some engines; but the steam-distributing details remain just where they were fifteen years ago, with some modifications in dimensions—none whatever in application. I believe that the cylindrical, corrugated fire-box, recently introduced by Mr. Cornelius Vanderbilt, has great possibilities in the direction of still higher pressures, and in that direction is an advance; but higher pressures alone will not increase average railway speed 20 per cent., and at least that increase is demanded.

The greatest stumbling block is the line itself, as it exists on most American railways between important terminals—the large cities—and it seems hopeless to expect any improvement until the roadbeds of the railways of the United States are constructed for high speed. There is no object in building higher-powered locomotives to drag trains up steep hills and around short curves, or upon gradients more or less heavy, by brute force. That is merely burning the candle at both ends, for it increases the expense of maintenance without correspondingly improving the service. High speed as obtained at present is costly—exceedingly so—and railway managers are well aware of it. The expense begins with the engine itself and its maintenance in and out of service. The American Railway Master Mechanics' Association recently appointed a commission to inquire into the details of cost and the replies to these inquiries are before me as I write. Briefly, these show that a modern high-speed locomotive costs from 25 per cent. to 50 per cent. more than one for ordinary speeds; the cost of fuel for high speed is from 15 per cent. to 20 per cent. greater than at ordinary speeds, while the cost of repairs is higher, but not stated in fixed terms. High speed, as understood by these investigators, means fifty to sixty miles an hour including stops. These are only the first items of extra cost, but all other and subsequent stops add to the increase of outlay, for the "great and gineral public," as Andrew Jackson called the people, seeing their fellows flying along the road, demand higher speed for their trains too. The inevitable result of the putting on of a few fast trains is the general speeding up of the entire passenger-train service of the railway line.

While it is evident from the testimony adduced that running at sixty miles an hour is more expensive than at forty miles an hour, it is not at all certain that the railways could get any more from the public if they provided the higher speed.* In some States the rate per mile is fixed by law, so that would have to be traversed; but the disposition of the public everywhere to get something for nothing by all possible means would entail more or less tedious legislation. Increased compensation is now obtained upon some trains, but it is for certain accommodations or appointments in the coaches, never for rapid transit pure and simple.

However this may be, there is nothing to prevent a high average speed with the present locomotives if the lines were constructed to permit it—that is, were they nearly straight and level instead of crooked and hilly—and confined to the specific object of high speed in lieu of general traffic. The usual course of a fast train is to start upon a schedule provided for it and make certain points at certain times. This could be done easily enough if there were no other trains in operation and no other events transpiring at the same time outside of the railway's affairs; but this is, of course, impossible, and the driver of a fast train is frequently held up several times when he has no reason to expect it by the exigencies of the traffic. In other words, he loses time from the start from causes beyond his control, and has to recover it by running faster thereafter. Where the road is fairly level and the grades light, there is no difficulty in very much exceeding the schedule; but it usually happens that exactly the reverse obtains and the old copy-book maxim—"Time lost is never regained"—comes true.

Suppose a railway line upon a causeway, elevated where necessary to clear natural or artificial obstacles, having curves of very long radii were demanded, but following an air-line generally between

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* As Mr. Rous-Marten pointed out clearly in his able article on "The Question of Cost of High-Speed Trains" in THE ENGINEERING MAGAZINE for February, 1901, the inducement to the railway is the increased travel and augmented passenger receipts which certainly and promptly follow every reduction of running time. Facilities create traffic, beyond any possibility of estimation in advance. Increased passenger mileage would justify an increase of cost per train mile; but Mr Watson argues soundly that the proper way to better American railway speed is by improvement of the permanent way, making it possible to run faster or pull heavier loads without increasing the cost per train mile. This has been the salient feature of the best American railway management as developed on the Lake Shore, the Pennsylvania, and others of the greatest and most successful railways in the United States.—THE EDITORS

New York and Philadelphia, where the sea-level is practically the same. Upon such a causeway there would be no difficulty whatever in reducing the time to eighty minutes, in lieu of the present one hundred and twenty minutes as the best time; there would be no difficulty in reaching New Haven in sixty minutes, instead of twice that time, and real rapid transit would be inaugurated, attended with perfect safety. One objection to such a line would be the first cost and maintenance, but neither of these objections is insuperable. A railway of very much this character is, in fact, now in course of construction under New York city, where the difficulties and consequently the cost are greatly enhanced from its subterranean position, and the contract calls for $34,000,000 for thirty-four miles, or $1,000,000 per mile. No elevated structure could be made to cost anything like that sum, and travel on it would be far safer than upon the surface of the earth. The first law of motion is that "a body in motion moves in a straight line with *uniform velocity* unless acted upon by some external force," and as there would be no external forces upon an elevated railway there would be no opposition to exceedingly high speed. In view of this proposition, or coincident with it, the expense of repairs to the locomotives would be rather less than at present, from the fact that the resistances are less, there would be a total absence of dust, and a uniform load from start to finish. This last feature is one of very great importance in transporting merchandise economically by steam power, and would open possibilities for compound locomotives which they have never yet enjoyed to show what they are capable of. It is well-known to experienced railway men that the race ground of any line is a level stretch of some length, and that the modern American locomotive with anything like a reasonable load behind it (and sometimes an unreasonable one) is capable of tremendous sustained velocities even with a dirty fire and by no means picked coal; given Pocahontas, or any other approved fuel, which burns and leaves the grates clean, a clear track and no hold ups, with a driver who is not afraid to ride fast, and he would give the public all the fast running they wanted, day in, day out, with the present engine. There is no occasion for either eulogizing or disparaging its abilities, it is simply a magnificent machine, and he must be unimpressible indeed who can stand beside a track when Apollyon goes raging by with ten or twelve coaches at sixty-five miles an hour, under the stress of a 200-pound whip laid upon his shoulders by a calm-eyed little man in the cab!

The comparative performances of American locomotives and those of other makes are not to be established in a magazine article, or, for the matter of that, in any article. Disquisitions and assertions are worthless in the face of train-sheets; they are the only arbiters, and time and again American locomotives have been compared with foreign locomotives and have shown themselves first in the rank of railway machines in all that is essential. Pound for pound, both in the load drawn and steam carried, over the same route, equal skill in driving being assumed in both cases, is the only test which can be made of two engines by different makers, as regards their capacities. The private or public opinions of more-or-less disinterested parties upon either side have nothing to do with the issue.

TYPE OF ENGINE MAKING THE FASTEST START-TO-STOP RUN IN AMERICA—55½ MILES IN 50 MINUTES ON THE ATLANTIC CITY FLYER.

The enormous mileage of successfully operated railway in the United States, much of it through thinly settled districts where the traffic has only a fraction of the density found in Britain or on the Continent; the comparative cheapness of American railway freight rates—stated by Mr. Phillips in The Engineering Magazine for May to be only about one-sixth of what they are in Britain, while first-class American passenger fares are barely equal to third-class English fares; the phenomenal performances in transport also described by Mr. Phillips in his study of ore movement in the United States—all these afford so substantial proofs of the efficiency and relative economy of American railway motive power that no other answer need be made to critics of the American engine.

Locomotives which can contribute to such results, when working over roads which are in the main far inferior to the average British standard, show by their own record the imperfect information or the prejudice of those who would cry them down as "costly failures" and "worthless at any price." As to the results lately given out in Great Britain, it is sufficient to quote Mr. Rous-Marten's comment in THE ENGINEERING MAGAZINE for February last:

> "But there is, of course, another side to the present question. It is quite certain that the American engines have laboured from the outset under one most serious disadvantage, wholly apart from that attaching to the insular prejudice of drivers and foremen. And this consists in the fact that they are not the sort of engines that American engineers or builders would have designed for the class of work they are put to. I do not wish to be misunderstood. I am casting no reflections on either British or American designers. I simply say that they view the requirements of traffic from different standpoints, and that a British engineer, keeping in mind the precise local requirements of British goods traffic and the special features of British methods and materials of construction, would design for a given class of duty an engine totally different from the one which an American engineer, bearing in mind the precise local requirements of *American* freight traffic and the special features of *American* methods and materials of construction, would design under the like conditions. No one who knows anything of American ways will contend that, had every point excepting the extreme dimensions been left to the Baldwin and Schenectady companies respectively, those builders would have constructed for the specific duty the same type of locomotive as that which they turned out to the order of the British railway companies. As it was, they had to do the best they could under stringent conditions."

If an indictment is to be drawn in re Higher Speed *vs.* American Locomotives, the American railroads themselves must be made parties to it. When they mend their ways, there will be no cause of action.

THE GREAT ELECTRICAL INSTALLATIONS OF ITALY.

By Enrico Bignami.

THE WATER-POWER PLANT AT PADERNO D'ADDA, LOMBARDY.

The hydro-electric power installation is always a widely interesting study, as representing the effective union of the most skilful work of the civil, the mechanical, and the electrical engineer. It has a deeper significance in its bearing upon economy in utilising the natural resources of the earth. It should not be unexpected, therefore, to find that the rapid extension in the use of power which characterises this age should cause an early development of water-power resources in countries like Switzerland and Italy, which are poor in coal supplies. But how rapidly this development has gone out is suggested with almost surprising effect by the contemplation of the 22,000-horse-power installation at Chèvres, described by Prof. Prásil in our preceding issue, or the Paderno plant of nearly 15,000 horse power which Signor Bignami reviews below. The great Niagara station, though designed for far greater ultimate output, began with about the same power delivery and much shorter transmission. And the interest is intensified when it is noted that, with wise cosmopolitanism of engineering practice, this huge enterprise has been brought to striking success by drawing the best in the way of machinery, methods, or advice from all the great industrial countries.—The Editors.

THE installation at Paderno d'Adda cannot be considered alone, as it forms part of a complex whole comprising under the general plan of a single undertaking all the public and private services of the Società Generale Italiana Edison di Elettricità in the city of Milan. The energy generated at Paderno is transmitted to Milan and received at the Porta Volta station, this being both a receiving and distributing substation and an independent steam-driven generating plant, in which the two power services are arranged for independent or joint supply to replace one another as may be required. From this station as a centre electrical energy is distributed for a large number of purposes. Part of it is received and transformed at the Santa Radegonda substation, whence it is delivered for traction purposes and for the feeding of lighting mains in the centre of the city. Another part of the main distribution goes to power and lighting customers in the industrial quarters of the city.

The Water-Power Plant at Paderno:—These water-power developments—dam, canal, tunnels, etc.—like all other similar engineering works, do not show in their finished condition the difficulties imposed by their design and execution. In this case the method employed in the work was as follows:

A few hundred metres below the famous bridge of Paderno there has been, for two centuries, the intake of the canal known as the Paderno canal, which was used to make a navigable waterway alongside of the rapids which here impede the passage of vessels at all stages of water. The intake consisted of a submerged dam and a pair of gates which regulated the admission of water to the canal. A happy idea seized upon these ancient works for the assistance of the new development; but neither the section of the canal nor the height of the dam was sufficient to handle the flow of 45 cubic metres of water per second required by the proposed electrical installation. The upper part of the dike was reconstructed and changed to a needle weir with movable collapsible frames (Figures 2 and 3) and the canal was widened from 9 to 13 metres, so that the velocity of flow in it is 1.37 metres (4.48 feet) per second, with a delivery of 45 cubic metres (1,588 cubic feet) per second. The widening extends for 690 metres

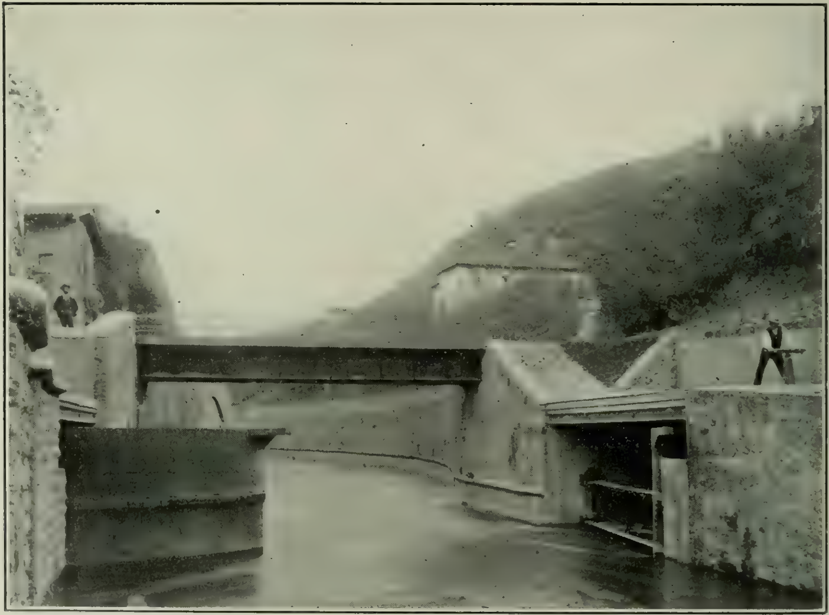
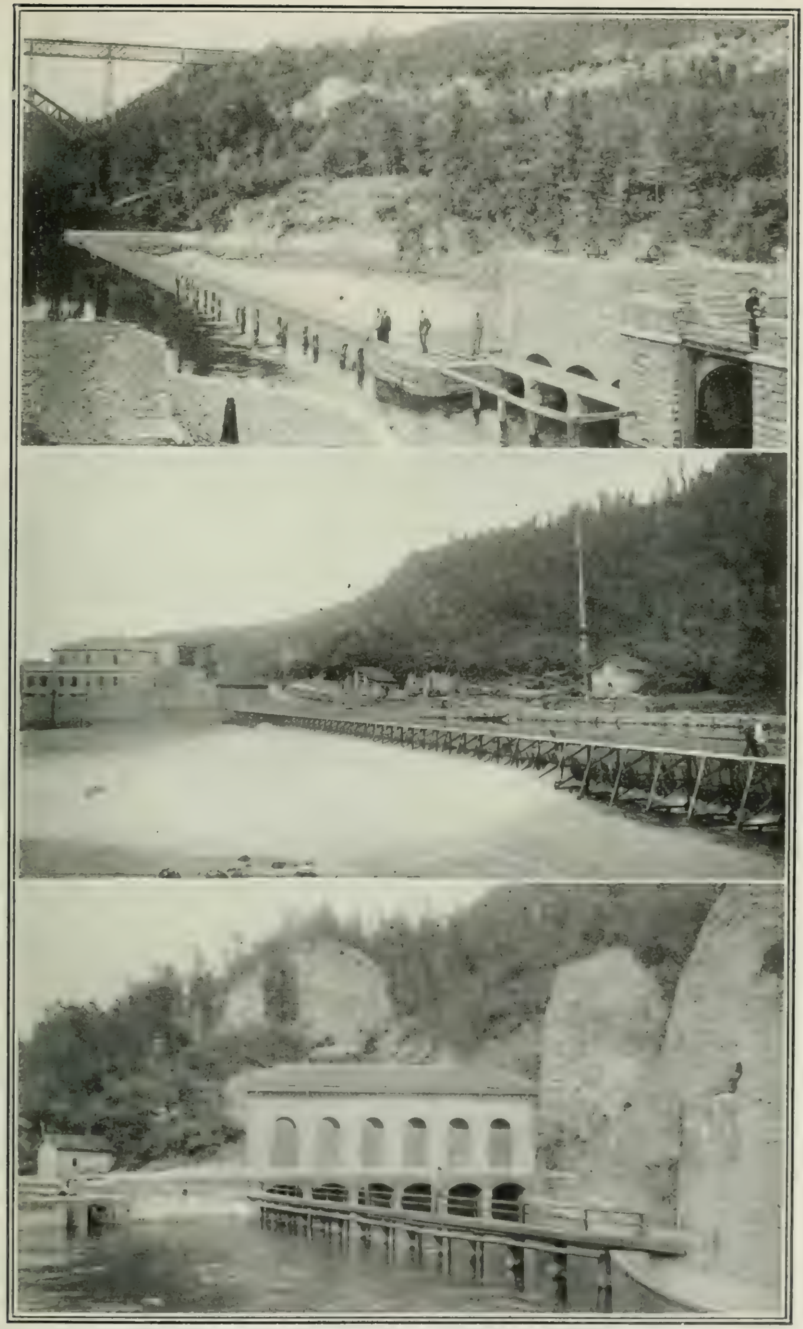


FIG. 1. ROTARY METALLIC SLUICE GATES AT THE HEAD OF THE SUPPLY CANAL.



FIGS. 2, 3, AND 4. THE TWO UPPER VIEWS SHOW THE UPPER AND LOWER SIDES OF THE NEEDLE DAM ACROSS THE RIVER ADDA. THE LOWEST ONE IS THE GATE HOUSE AT THE HEAD OF THE SUPPLY CANAL

(2,263 feet) from the head of the canal to the "Conchetta" where the first of the renowned seven basins is found.

At this point is the real head gate of the new canal, (Figure 4) built over six sluiceways, each furnished with hand-operated gates. A few yards further, the canal, leaving to the left the boat canal which traverses the smiling valley of the Adda, enters a tunnel 105 metres (344 feet) along whence it flows out into an open cutting of a mean depth of 8 metres and 230 metres long; thence it passes through another tunnel 278 metres long, a second cutting of 352 metres, and then the last and longest of the tunnels, 1,005 meters (3,296 feet) long. The end of this tunnel is shown in Figure 6. The canal is, altogether, 2268 metres (7,449 feet) long with a cross-section of flow of 16.80 square metres (180.8 sq. feet) and delivering 45 cubic metres (1,588 cubic feet) per second under a velocity of flow of 2.70 metres (8.85 feet) per second. The last tunnel abuts at a point where the configuration of the valley is, so to speak, convenient for the situation of a water-power works. Here a large basin receives the water coming out of the tunnel and allows its velocity to fall, before it passes through the head gates of the steel penstocks, to about one metre per second. At the left of this basin is the crest of a great waste weir,

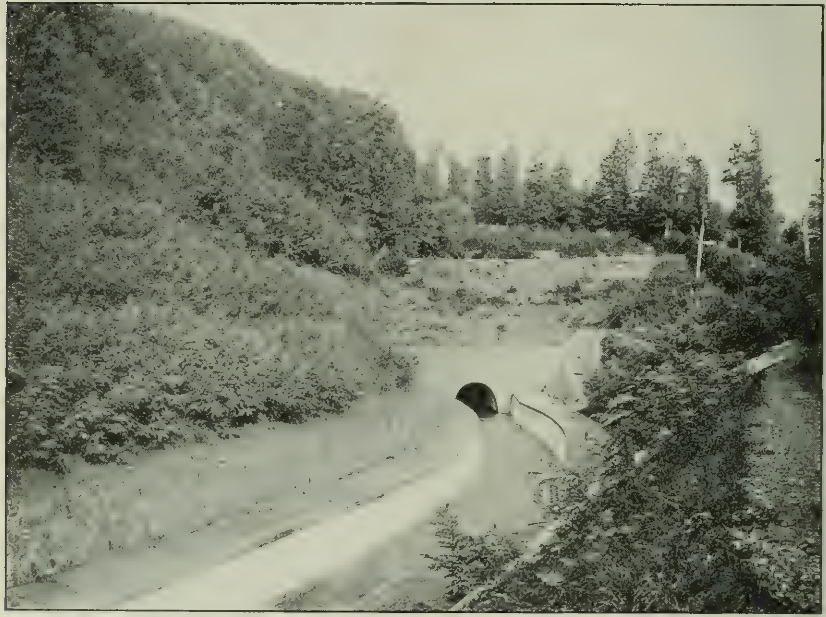


FIG. 5. MOUTH OF THE FIRST TUNNEL, AND PART OF THE CANAL IN EXCAVATION CUTTING.

having an ultimate capacity for 52 cubic metres of water per second. The sluiceway is in the form of a gigantic flight of stone steps, 29 metres (95 feet) high and 30 metres wide. Over this the falling water breaks so that the great force of its fall is weakened and gradually destroyed. Figure 7 gives an excellent view of this fine artificial waterfall.

From the receiving basin, seven steel penstocks, each 6 ft. 11 inches in diameter and built of plates from 7/32 to 1/2 inch thick, lead to the turbines (Figure 8). These pipes rest upon the natural slope of the ground, their length being 205 feet. Each is provided with a gate at the top, while the flow to the turbine is controlled by a butterfly valve at the bottom. The tail water from the wheels goes first into a large basin, whence it is discharged, not directly into the river but into the boat canal. This is done to prevent interference with the navigation of the latter by too great withdrawal of water.

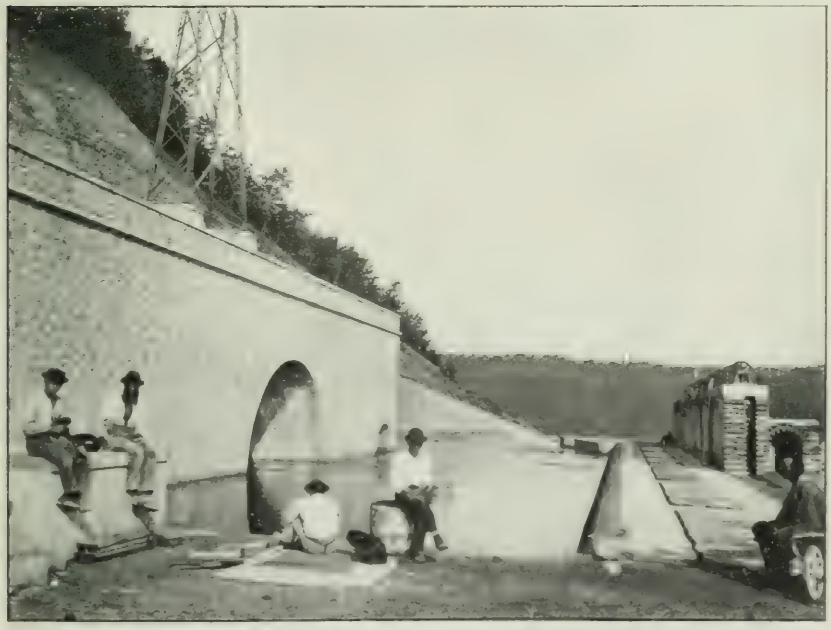


FIG. 6. OPENING OF THE THIRD TUNNEL. BASIN AND HEAD OF PENSTOCKS TO THE TURBINES.

At low water the net fall, with 45 cubic metres flowing in the canal, is 28.82 metres (94.5 feet); at times of freshet this is reduced to about 82 feet. To compensate for this decrease in head, all the work—canals, tunnels, wheels, etc.—was designed for an increased flow of 52.25 cubic metres, this amount being needed to maintain the

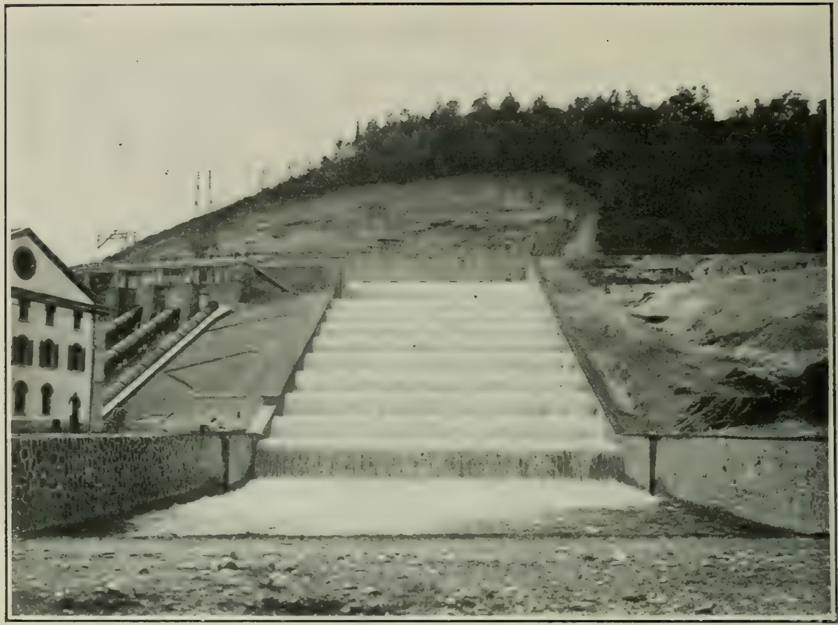


FIG. 7. STEPPED SPILLWAY FROM THE BASIN ABOVE THE TURBINES.

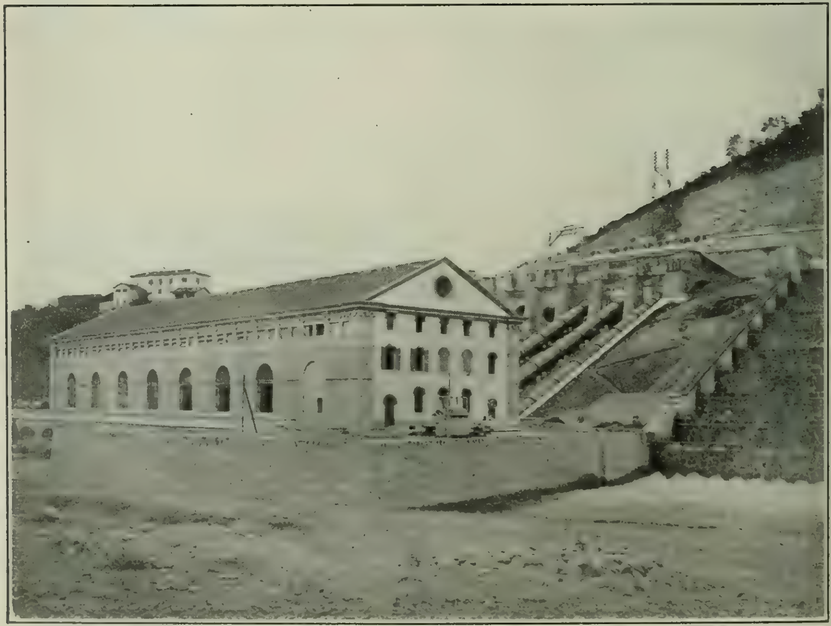


FIG. 8. THE PADERNO HYDRO-ELECTRIC STATION, SHOWING THE PENSTOCKS AND THE SUPPLY BASIN ABOVE.

same output with the lower head. The power theoretically available from this head and volume is 17,300 horse power, or, allowing 75 per cent. efficiency in the turbines, an actual delivery to the dynamo shafts of 13,000 horse power.

Turbines and Accessory Apparatus:—The power-station building, which is 61 metres (200 feet) long, 20.4 metres (67 feet) wide, and 10.95 metres (36 feet) high to the spring of the roof, is almost entirely occupied by the main machinery room. Its north wing is used for storage and for the lodgings of some of the working force of the station.

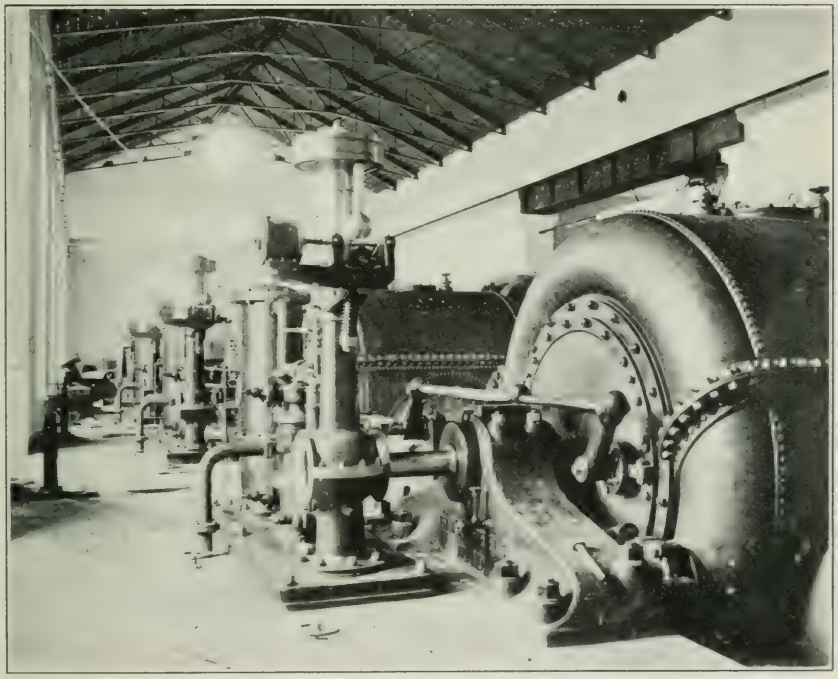


FIG. 9. PADERNO HYDRO-ELECTRIC STATION. THE TURBINE GOVERNORS.

In the main dynamo room there are now installed six units, each of 2,160 horse power; the complete installation will comprise seven. Each is composed of one horizontal-shaft turbine direct-coupled to one alternator through an adjustable Zodel coupling (Figure 9). These were the first turbines of more than 2,000 horse power built in Europe, and the credit of their success belongs to Italy. The house of Riva, Monneret & Co. built the wheels, which both in output and operation successfully met the requirements of specifications and guarantees.

The turbines are of the horizontal-shaft pattern, with inwardly directed admission and axial discharge. The runner is of American type, with multiple curves of which the form was established after numerous experiments rather than as a result of calculation. Normal speed of these units is 180 revolutions per minute. Their governors are of the Ganz type, slightly modified to meet the requirements of this particular installation.

Dynamos and Accessories:—The dynamos, as well as all the other electrical apparatus, were built by Brown, Boveri & Co. of Baden, Switzerland. Among the various engineering firms bidding on the work this concern was the only one that presented a completely worked-out design—one that was a little hazardous, perhaps, for its time. They proposed feeding the transmission line at 13,500 volts generated directly upon the dynamos without transformation. I call this hazardous because, in 1895 and in Italy, installations at higher pressures than 6,000 volts were unknown. This, too, was the first time that dynamos of 2,000 horse power and 15,000 volts had been constructed. The machines are truly admirable from all points of view, and their success marked a new step in the use of high electrical pressures. In Figure 10 one of these machines is shown. Paralleling these generators has never given any trouble. They can be coupled even when running light, showing that the turbine governors work ad-

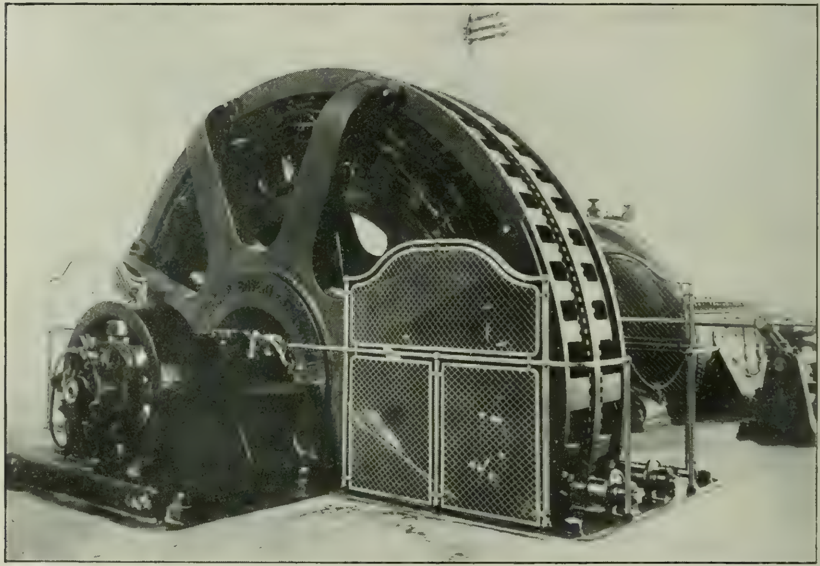


FIG. 10. PADERNO GENERATING STATION. TURBO-ALTERNATOR OF 2,160 HORSE POWER AT 13,500 TO 15,000 VOLTS.

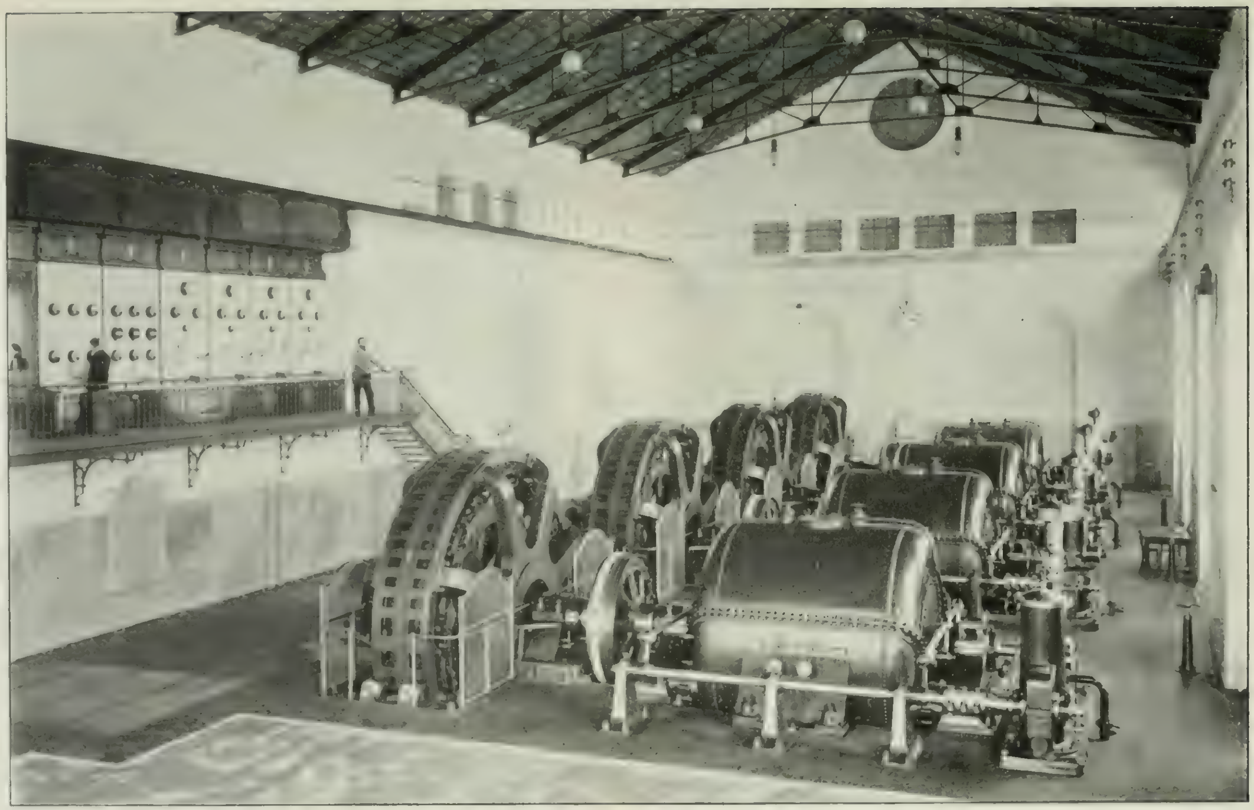


FIG. 11. TURBINE AND GENERATOR ROOM, PADERNO GENERATING STATION.

mirably. The load is divided among the machines by means of small auxiliary motors working on the governor gates and controlled from the switchboard, shown in Figure 12. It is interesting to note, also, that parallel operation of the alternators at Paderno and the steam-driven machines in the Porta Volta station at Milan is very easy of accomplishment.

Frequently, during the building of the Paderno plant, recourse to these Milan machines has been necessary. Connecting in has never presented any difficulty and the two sets of machines, twenty miles apart and driven by prime movers of different types, have worked together as well as if they had been installed alongside of each other in the same station.

The dynamo leads are carried in conduits under the floor to the switchboard, the front of which is on the western wall of the dynamo room. In an installation where such high electrical pressures are handled the switchboard is an element of prime importance, for upon it the current is governed and handled and with its simple levers and handles is controlled the immense power invisibly transmitted by the wires. This main switchboard was built with great care and occupies altogether a space of 160 square metres.

In planning this delicate and important part of the station the engineers of the company and the builders made use of the experience

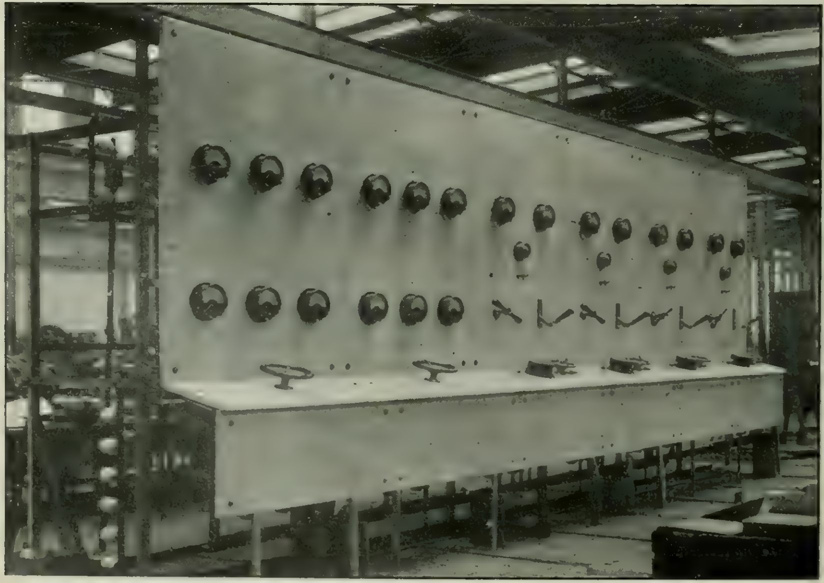


FIG. 12. SWITCHBOARD FOR MEASURING INSTRUMENTS.

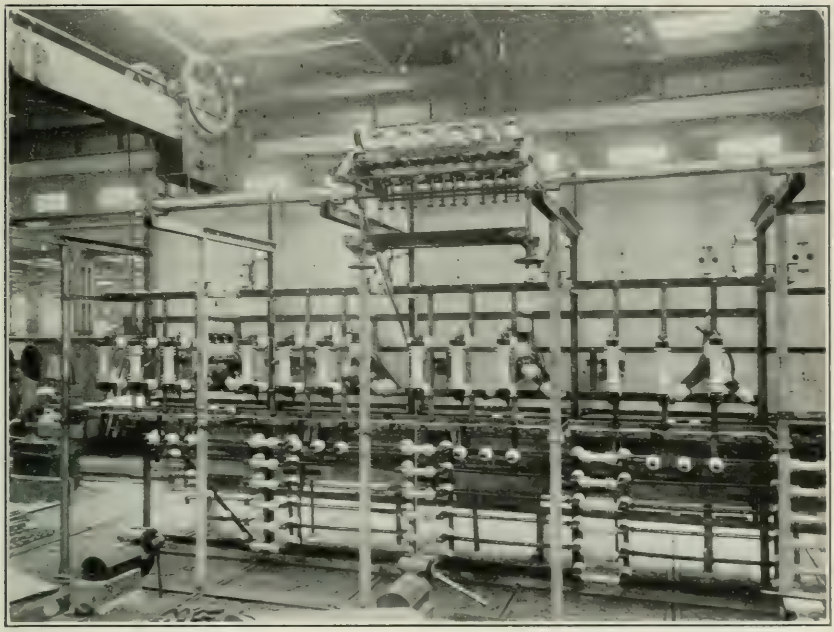


FIG. 13. SWITCHBOARD WITH CIRCUIT BREAKERS.

gathered in the working of the 3,600-volt installation at Milan, and, aside from some points of which mention is made below, this experience was not without advantageous outcome. The most important parts of the switchboard are the circuit breakers and fuses. The circuit breakers have been very successful, making a swift break under oil and permitting a current of 100 amperes at 15,000 volts to be broken without trouble or the appearance of more than a small spark in the oil. Fuses, however, have not given such entire satisfaction. The type employed is a tube, open at both ends, in which is stretched a lead wire. (Figure 13.) While the working of the fuses has not always been perfect, I should say here that accidents on their account have been less frequent on the 15,000-volt line than upon the distribution circuits working at 3,600 volts.

The Transmission Line:—Many of the problems presented by the transmission line were novel and without precedent, at least in Italy; especially so were the phenomena of self-induction which had caused much trouble in former undertakings. The line is, naturally, that part of the installation most liable to exhibit trouble, particularly when it is worked at very high tension, and is exposed to the accidents of weather and the risk of malicious interference. The transmission line

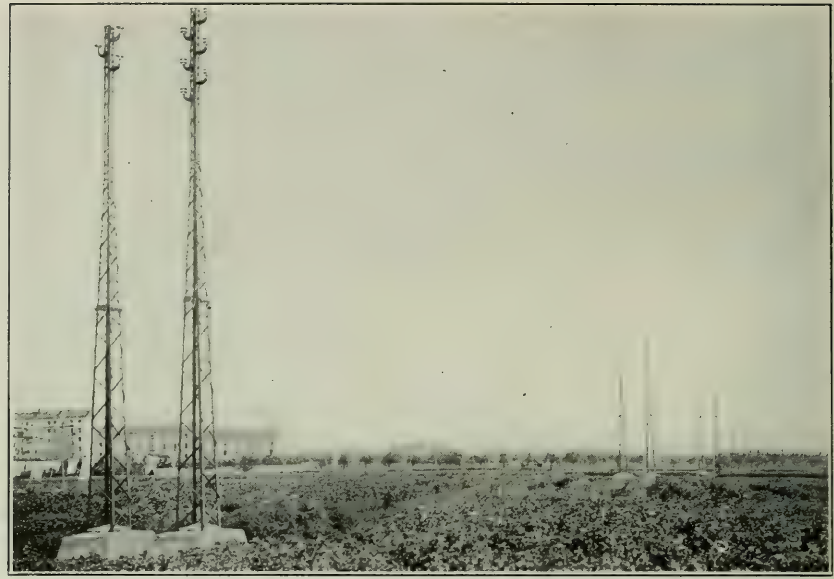


FIG. 14. PADERNO-MILAN TRANSMISSION LINE, SHOWING ORDINARY TYPE OF POLES.

from Paderno to Milan is carried on strong and handsome structural iron poles, built by the Savigliano shops (Figure 14). They are set in pairs, two metres apart, with an interval of 60 metres (197 feet) between pairs. The pole tops are 33 feet high above the ground, and each pole is capable of carrying 9 copper wires of 9 millimetres diameter (about No. 00, B. & S. gauge). By this double arrangement of the line, which consists practically of two lines parallel with one another, repairs or alterations are easily effected, one side carrying the whole load while work is in progress on the other.

Some curious fears and doubts were expressed when it was decided to use metallic poles on this line. It was said that it would be dangerous to touch the poles; that the presence of these conducting bodies in the magnetic field surrounding the live wires would augment the self-induction of the circuit and increase the energy losses. On the other hand, a comparison of the depreciation costs of wood and iron poles shows a difference in favour of the wooden poles, more than offset, however, by the advantages of the iron supports. These are greater safety and strength, with a consequent reduction of the number of poles necessary, carrying with it an equivalent reduction in the number of insulators and thus combining economy with a lessening of the number of points of weakness in the line.

Practice has demonstrated that danger to persons touching the poles is absolutely without existence, and that the alarm felt on other grounds was equally without foundation. The line as constructed is very stable and is one of the most handsome in existence. During the year 1900 there were twelve storms. Service interruptions due to storms, since the commencement of operations in 1898, have been only four in number so far, and of these two are attributable to bad working of the lightning arresters, which held an arc. After the two instances referred to, which occurred in 1899, the number of air gaps in series with each Wurts lightning arrester was increased from 42 to 54, since which there has been no further inconvenience.

It is remarkable that upon this line, traversing a region almost wholly without trees of high growth, in which storms are very violent, and where hail is the cause of frequent devastations, the number of discharges of the lightning arresters has been very small. It is rare for more than four or five discharges to take place during a storm. Does this fact depend on local conditions, or do the iron poles play a protecting *rôle?* Is it not, perhaps, due to a continuous slow discharge of the line by the arresters preventing the accumulation of large electrostatic charges?

Upon the same poles with the transmission wires are carried the Paderno-Milan telephone lines. Concerning the working of the telephone I can do no better than quote Signor Guido Semenza, one of the

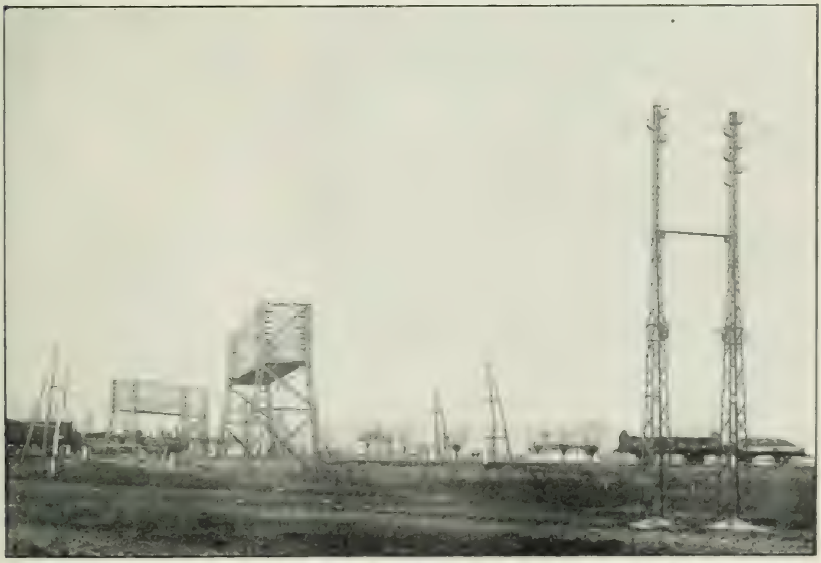


FIG. 15. TRANSMISSION LINE, SHOWING BRIDGE ARRANGEMENTS FOR CROSSING THE LINE OF THE MILAN-VIGEVANO RAILWAY.

engineers and a director of the Edison Company. His report of the matter is as follows:

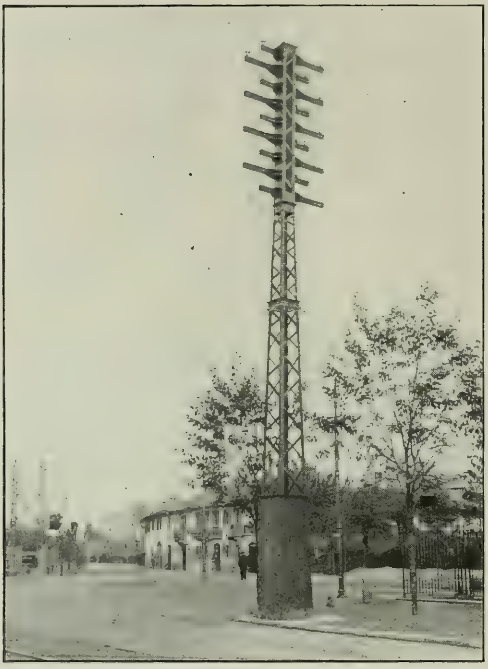


FIG. 16. TRANSMISSION LINE SPECIAL POLE AT THE ENTRANCE TO MILAN.

"Considerations of economy and convenience of inspection frequently lead to the erection of the telephone line on the same poles with the transmission wires. At the outset of our exploitation we concluded that induction would cause such noises in this case as to disturb or even forbid telephone communication. The remedy, however, is very easy to apply when the true causes of the disturbance are understood.

"I feel justified in saying that the noises disturbing the telephone are caused by electrostatic induction. Electromagnetic induction, in our case, at least, gives no trouble. Our telephone circuits are not transposed or spiraled. Nothing has been done to counteract electromagnetic induction, nevertheless the noise has been almost entirely suppressed by very carefully insulating all parts of the telephone circuits from the ground."

On curves in the line and at angles, as well as at the point where the line enters Milan, a special form of pole is used. (Figure 16.) At the three crossings of the line over railways, at Sesto, Monza, and Milan, veritable iron bridges were erected to meet the requirements of the railway companies. Crossing at right angles only is attempted. (Figure 15, page 711).

A serious element of difficulty was found in the insulators for iron-pole line work. Two types were adopted, one being used on one of the parallel elements of the transmission line and the other on the other element. The first is of American design, known as the "helmet type"; the other, having four conical petticoats, was produced by the house of Richard-Ginori at Milan, each insulator being tested to 45,000 volts.

The course of the transmission line does not follow the roads but is almost straight. It measures altogether 32,785 metres (24 miles). The company owns the right of way along the line for a strip three metres wide. On the heights near Monza the line branches and a circuit is taken off to feed a manufacturing village in that neighbourhood. The line goes into the city of Milan, turning to avoid the Monumental Cemetery, and ends at the Porta Volta station, where it is dead-ended upon two solid structural-iron poles (Figure 17). A series of Wurts lightning arresters protects the line at this point and the conductors are carried into a special switchboard, passing thence to the transformers.

The Porta Volta Station:—The bank of transformers for reducing the line tension to 3,600 volts is placed on an intermediate floor of the station in a room by itself. The switchboard controlling them is placed in a room immediately above the transformers. At present the transformers, which were made by Ganz & Company, of Budapest, number twenty-five and each is rated at 350 kilowatts. A blower installation operated by electric motors is used to furnish air for cooling these colossal pieces of machinery.

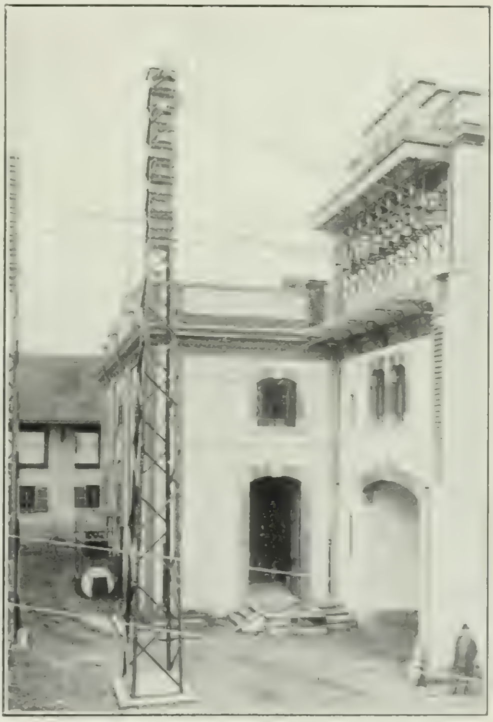


FIG. 17. PORTA VOLTA TERMINAL OF THE AERIAL TRANSMISSION LINE FROM PADERNO TO MILAN, SHOWING ANCHORAGE POLE.

The Porta Volta station—substation and independent generating plant at the same time—is, as mentioned above, the centre of distribution for Milan. So far as the station is concerned its sources of energy are twofold—the transformers, feeding into it, energy coming from Paderno, and dynamos coupled to steam engines in the station itself (Figures 18, 19, and 20). These two sources furnish energy under the same form—that is, three-phase currents [illegible] a frequency of 42 cycles per second and under a tension, in the intermediate network, of 3,600 volts. It is possible, on account of this arrangement, to combine upon the switchboard at this station energy coming from the waterfalls at Paderno and that produced by burning coal in the building itself, so that the two independent sources of energy work together, or either one may be substituted for the other. At present a considerable enlargement of this station is under construction, a new steam-engine unit of 4,800 horse power. This unit will consist of a Brown steam turbine and a three-phase alternator, giving 3,600 volts and 42 cycles per second under a speed of 1,200 revolutions per minute.

Distribution Lines:—The distribution of electrical energy, of which the Porta Volta station is the centre, can be divided into two kinds; that which is made directly by means of three-phase alternating current, and that which is made by direct current after transformation at the Santa Radegonda station (Figure 21). The three-phase distribution is made by means of seven underground cables working at 3,600 volts, distributed from the Porta Volta station. Two of these cables run semicircularly around the city in one direction, two others go in the opposite direction, the four being brought together at a

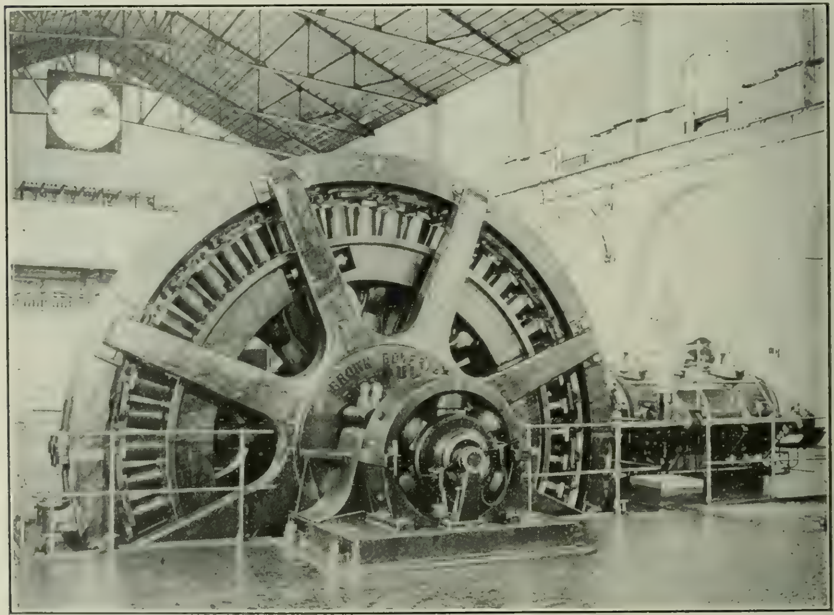


FIG. 18. GENERATING UNIT AT THE PORTA VOLTA STATION. ALTERNATOR DIRECT-CONNECTED TO 1,000-HORSE-POWER ENGINE.

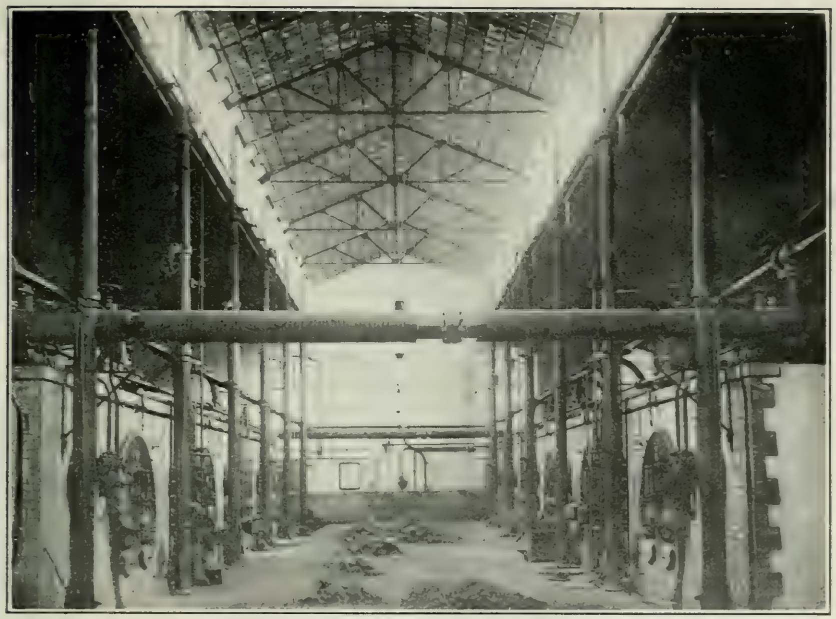


FIG. 19. BOILER ROOM, PORTA VOLTA GENERATING STATION.

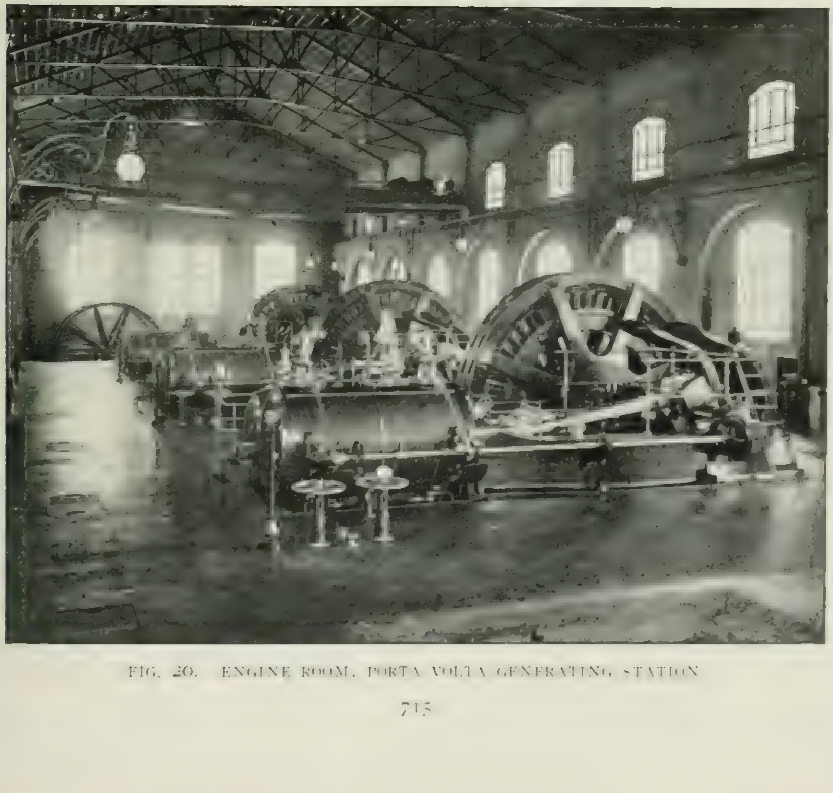


FIG. 20. ENGINE ROOM, PORTA VOLTA GENERATING STATION

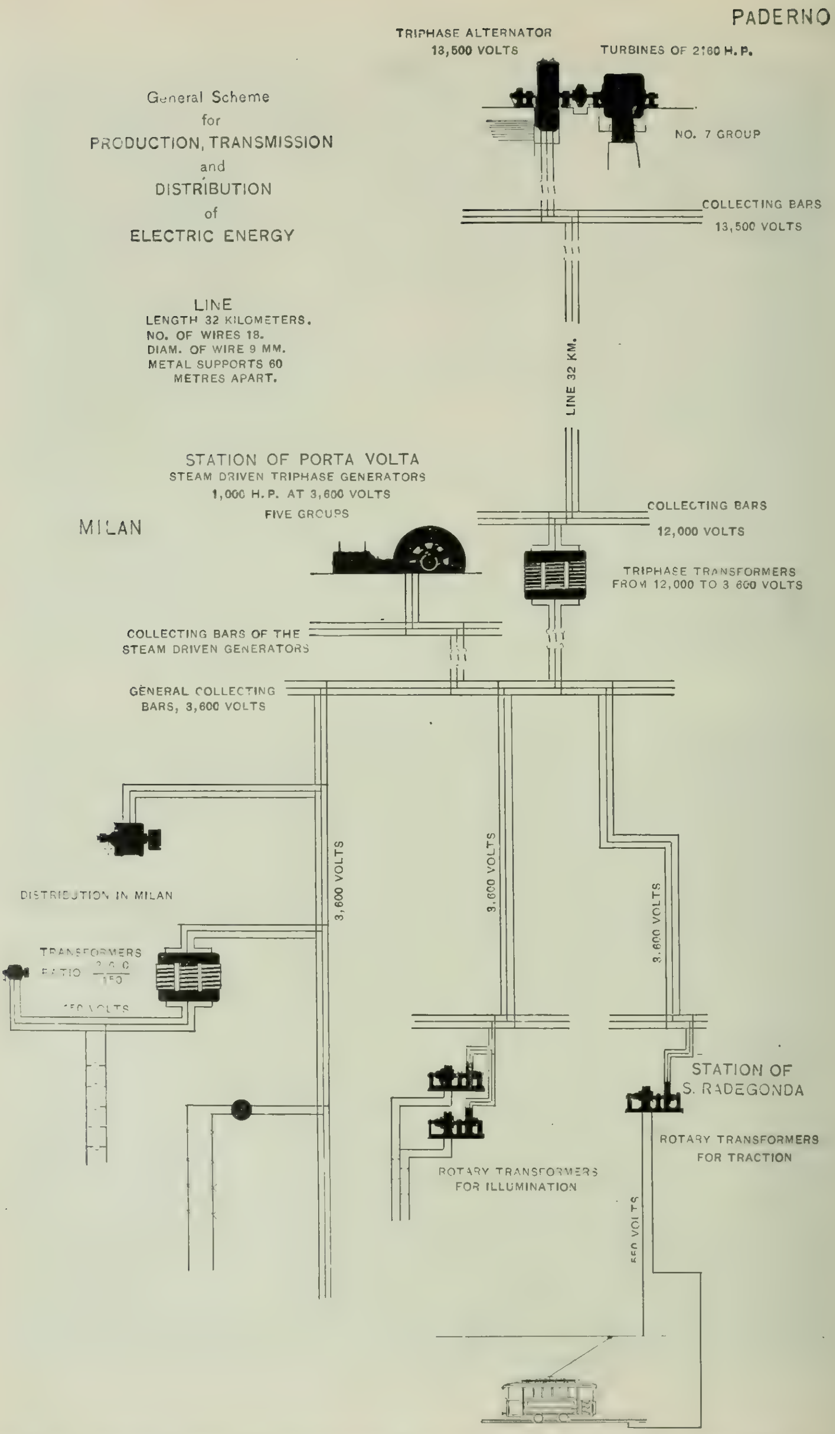


FIG. 21. GENERAL PLAN OF GENERATING, TRANSMISSION AND DISTRIBUTION SYSTEM.

point opposite the station and forming thus a great loop which is the basis of the high-tension network. Two other cables traverse the town diametrically and there is a branch leading off to the Santa Radegonda transformer plant. In conjunction with the principal conduit carrying these cables there are installed substations, consisting of columns built on public ground, or sometimes upon small private enclosures having an entrance upon the street. These substations have a double purpose; they contain transformers for local distribution and also serve as points of discontinuity and branching for the high-tension network. The distribution is made at 3,600 volts only to the larger motors. For all other consumers the tension is 150 volts. The transformers (Figure 22) of each substation feed, so to speak, at 150 volts a small local network composed of underground cables, the mean radius of such a system being about 1,000 feet.

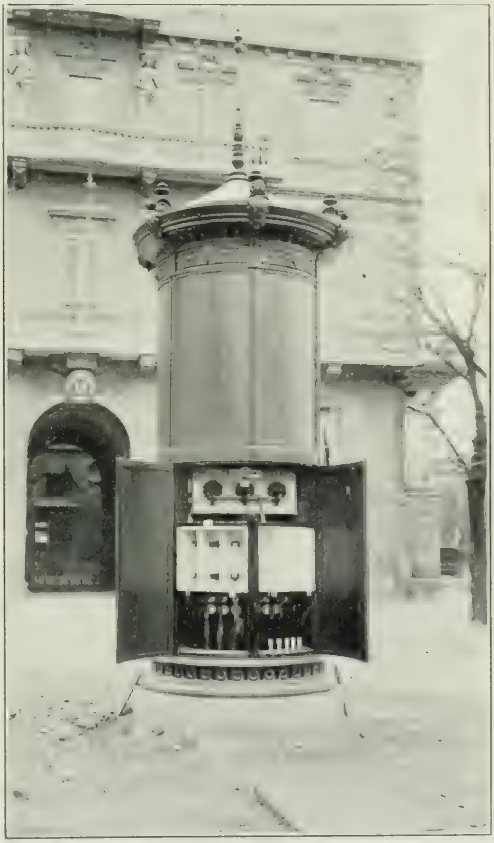


FIG. 22. CONTROLLING AND DISTRIBUTING STATION ON THE TRI-PHASE SYSTEM.

In Figure 23 is shown in diagram the disposition of the circuits and apparatus in one of these transformer pillars. The sketch shows the primary cables, the transformer, and the secondary cables grouped two by two in parallel upon two systems with separate bus-bars. Each of the secondary 150-volt cables is furnished with its own switch. For the primary cables a single switch of the General Electric Company's type serves to cut out any of the various cables. This switch is connected on one side with the bus-bars upon which the primary cables terminate, and on the other side with a second system of bars, independent of the first but capable of being put in connection with the cable by means of three movable plugs. The switch serves to connect the cable directly with the main bus-bars, and opening it cuts out all of the local circuits in the substation pillar. It is stated that this simple but new system has enabled the cost of the substations to be considerably reduced. Lighting installations are fed off the same network serving power users, and it is remarkable how satisfactory this simultaneous service has been to the customers.

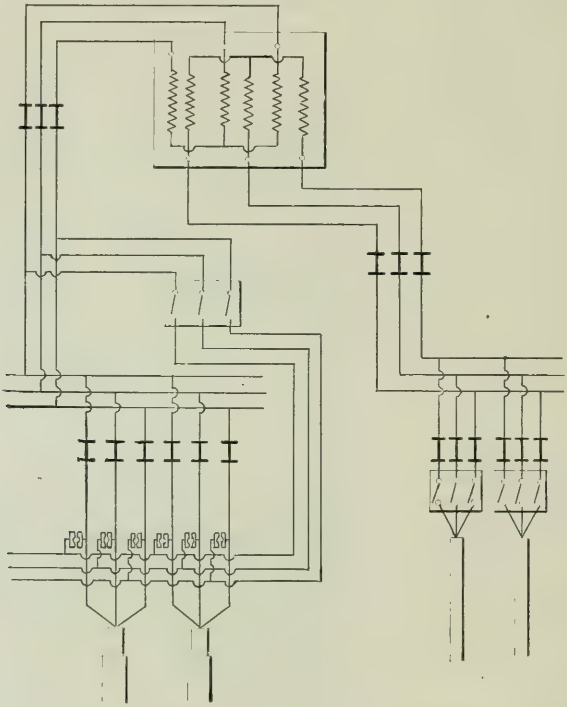


FIG. 23. DIAGRAM OF ARRANGEMENT OF CIRCUITS AND APPARATUS IN A TRANSFORMER STATION.

The network in consideration is calculated to take care of a power distribution of more than 8,000 horse power with a mean loss of 4 per cent. All of the cables were furnished by Pirelli & Company.

The Santa Radegonda Station:—The second part of the distribution in the city of Milan is made through the Santa Radegonda substation. Four three-phase cables working at 3,600 volts bring current to this station where, alongside of the first Edison steam plant, has been built a transformer station containing all that is of the most modern in the way of machine and switchboard equipment. In this sta-

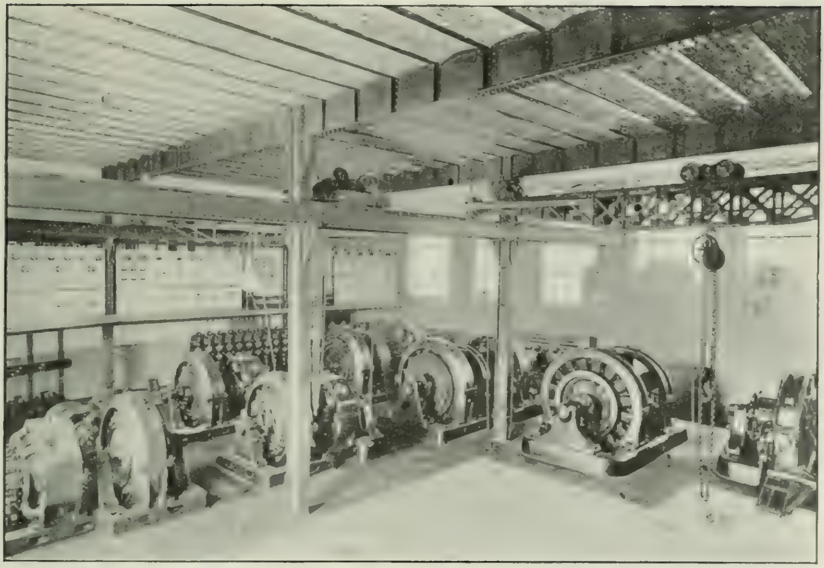


FIG. 24. NEW TRANSFORMER STATION OF SANTA RADEGONDA, FOR CONTINUOUS-CURRENT LIGHTING AND TRACTION SERVICE.

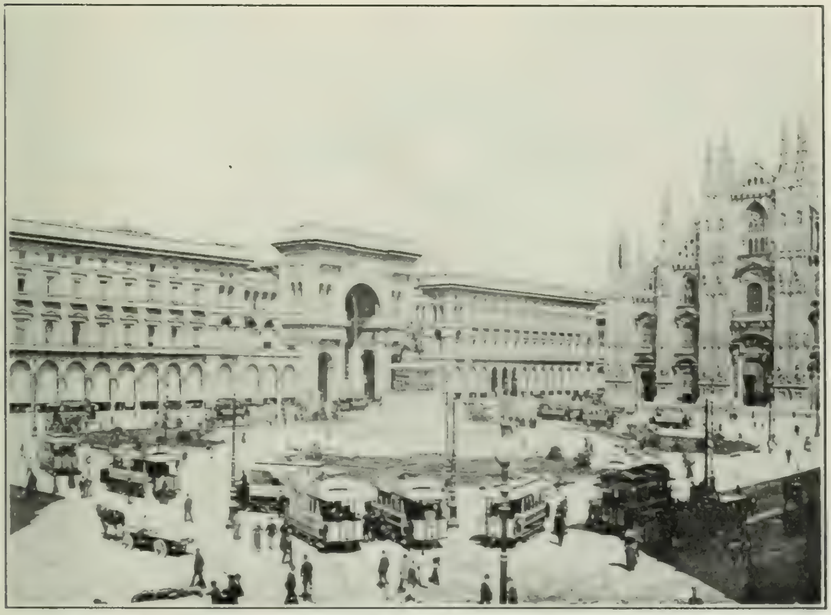


FIG. 25. THE CATHEDRAL SQUARE, MILAN—A CENTER OF THE TRAMWAY SYSTEM.

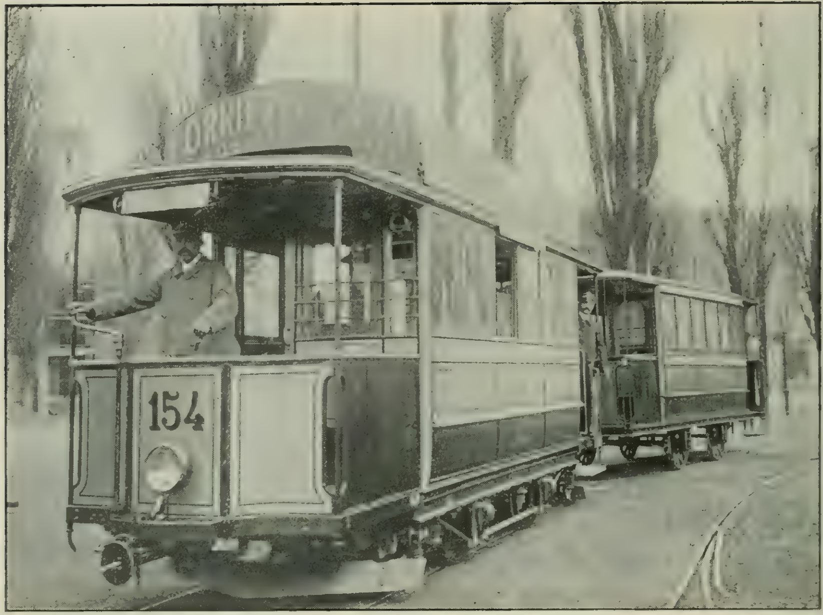


FIG. 26. ORDINARY TYPE OF MOTOR CAR AND TRAILER, MILAN TRAMWAYS.

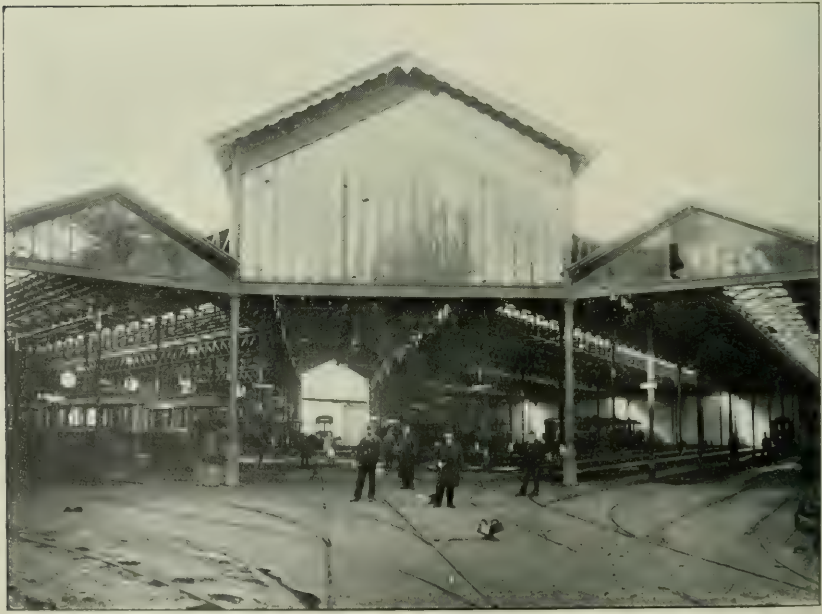


FIG. 27. CAR HOUSE AT PORTA VOLTA, MILAN TRAMWAY SYSTEM.

tion there have been installed five large batteries of accumulators (one for street railways and four for lighting) of the Tudor type, furnished by the firm of Dossmann, of Gênes, and having a capacity of 2,000 ampere hours on a one-hour discharge-rate. The steam-power central station at this point has been for some time finished, as have all its accessory parts. So important are the services that these batteries have already given at the height of the peak of the load and during difficult seasons of bad weather or unusual darkness, that notwithstanding the relatively high cost of the installation the company has reached the conviction that the battery fulfils an absolutely necessary requirement. The batteries are handled through a regulator of the Thury type.

In the same dynamo room are machines of two different classes; those serving the lighting circuits and those giving current for traction. Each machine is composed of a three-phase motor working at 3,600 volts, direct-coupled to a direct-current dynamo. For railway service there are four units of 500 kilowatts each. For lighting there are seven of 250 kilowatts and two of 60 kilowatts. Part of this apparatus was furnished by Brown, Boveri & Company, of Baden, Switzerland, and part by the General Electric Company, of New York (Figure 24). Each of these separate services has its own switchboards. Those handling the lighting current are connected with the boards in the old station with which the new one can work in parallel.

The rotary transformers for the railways are not different from those for the lighting service, except in their output and in the winding of the dynamos on the direct-current side for 550 volts instead of 125 volts, which is the standard pressure for direct-current lighting. Each of these rotary transformers is composed of a three-phase, synchronous, 3,600-volt motor directly coupled with a constant-current dynamo. Preference was given to the use of synchronous motors in place of induction motors (which would present a less difficult problem at starting) on account of other well-known advantages which the former type possesses.

The starting of the synchronous motors in this station is accomplished as follows: Direct current at 110 to 120 volts, produced either from the new or old machinery, is always to be had. The units are started up by using the direct-current dynamo as a motor, feeding it from this current and cutting out resistance in its armature circuit until the apparatus is running at synchronous speed. When this is secured connection is made on the alternating-current side and the apparatus runs in its usual way. In starting the railway apparatus a different process is necessary, since there is no 550-volt current at disposal to start the apparatus in the way mentioned. The apparatus is started as a motor on the 220-volt current and resistance is then introduced into its field circuit until it reaches synchronism, a special rheostat being installed for this purpose.

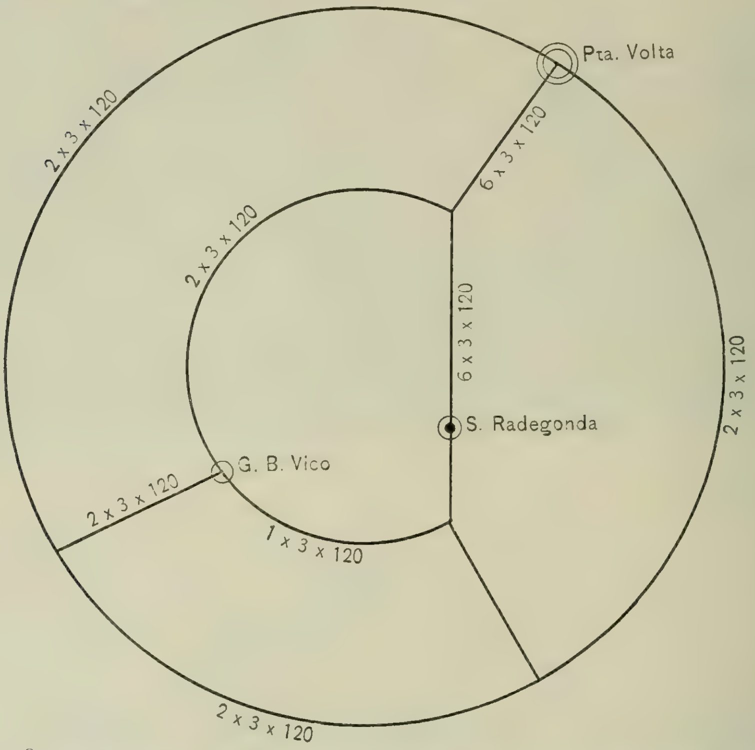


FIG. 28. DIAGRAMMATIC PLAN OF THE PRINCIPAL ANNULAR DISTRIBUTION SYSTEM.

The underground network for current distribution, starting out of these stations and serving the business centre of the city of Milan, is that of the old 110-volt Edison plant, of which the first cable was laid in 1883 (Figure 28). The railways are fed at 550 volts by means of overhead trolley wires, fed in turn through fifteen underground feeders.

The G. B. Vico Substation:—At this station, which is maintained exclusively for the service of public arc lighting, the steam engines formerly used have been replaced by electric motors driven from the three-phase network. At present there are 4,242 lamps used for public lighting and about 600 for private lighting. In the whole city there are installed about 110,000 incandescent lights.

Operation:—From tests made upon the installation at Paderno it has been concluded that the efficiency of the alternators is 94.8 per cent., and that of the transmission line is 92.6 per cent. The loss due to this long line is thus only 7.4 per cent. In test work the dynamos have been driven up to 20,000 volts and the line pressure up to 17,000 volts. In testing the efficiency of the machines the various losses were measured separately. This loss under full load is almost exactly equal to 5 per cent. and can be subdivided as follows:

Loss by friction and windage..........	1.25 per cent.
Iron losses	2.50 " "
Copper losses	1.15 " "
Losses in the exciter.................	0.10 " "

At full load and under a power factor of 80 per cent. the efficiency is in the neighbourhood of 94 per cent.

During the time of installation of the Paderno plant the work of laying the tramway lines in the city was going on actively and in December, 1898, the last line operated by animal traction—that of the Porta Ticinese—was traversed by electric cars. Milan is one of the few cities of Europe of which the tramway lines have been completely changed over to mechanical traction.* The tramway system altogether has more than 100 kilometres (62 miles) of single track, and 206 motor cars. In all, the company has in commission 260 motor cars and 50 trailers (Figure 26). All of the lines were constructed with material furnished by the General Electric Company, of New York, and the same company also built the electrical equipment of the cars. The

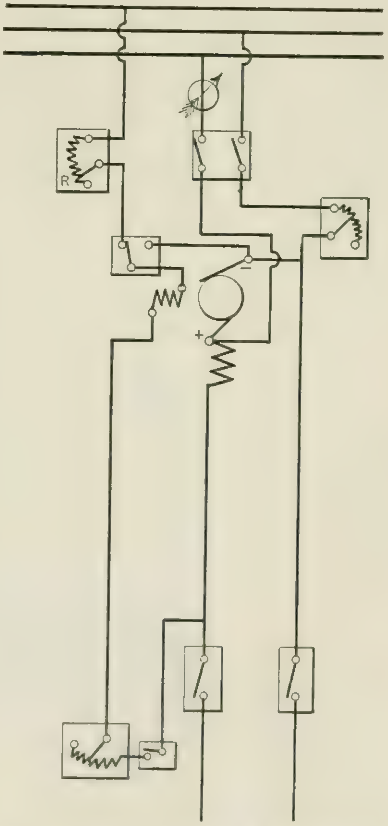


FIG. 29. ARRANGEMENT OF ROTARY TRANSFORMERS FOR TRAMWAY SERVICE.

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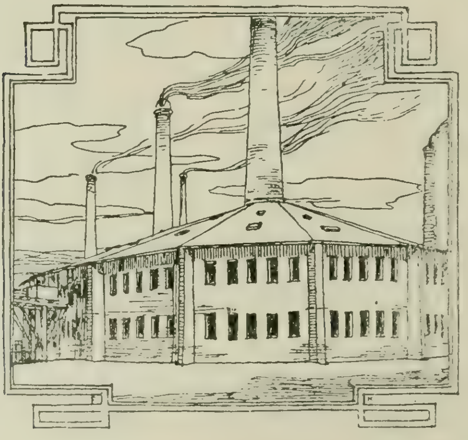
* This comprises lines already described in THE ENGINEERING MAGAZINE for November, 1900, running out to the Monumental Cemetery and the Musocco Cemetery, upon which there are special cars for the transportation of the dead.

track, of the Phoenix type, was laid by the municipality of Milan and remains its property. Car houses are three in number; one for 200 cars, one for 40, and one for 80. The first, erected at the Porta Volta station, is remarkable for the novelty of its arrangement, which greatly facilitates the going in or coming out of cars (Figure 27). A fourth car house is under construction.

All of the car lines come in to the Cathedral Square (Figure 25), comprising lines lately opened to the public between Milan and Monza, eleven miles, between Milan and Affori, nine miles, and that which will shortly be opened between Milan and Corsico, 3.8 miles. For the line to Monza at Sesto San Giovani, half-way between the termini, a substation furnished with a battery of accumulators has been put down, the battery being floated across the circuit and having a capacity of 800 ampere hours at one-hour discharge rate. This station was placed just where the transmission line from Paderno crosses the distribution line and the railway, and receive its power directly from the transmission line by means of conveniently situated transformers.



THE PROPER DISTRIBUTION OF ESTABLISHMENT CHARGES.

By A. Hamilton Church.

II.—VARIOUS PLANS FOR DISTRIBUTING EXPENSE TO INDIVIDUAL JOBS.

Mr. Churchs' first paper, which appeared in our July issue, pointed out the vital necessity of accurate cost-keeping if business success is to be secured, especially in this era of rapid growth and extension of manufacturing enterprises and of increasing keenness of competition. In this article he analyses the chief accepted methods of apportioning general expense to individual jobs, and states their deficiencies, with a view to making clearer the claims of the system which he advocates. His following paper will develop more fully the method of keeping costs by the scientific machine rate and the supplementary rate.—The Editors.

ASSUMPTION is made in what follows that a system of taking out prime costs is already in use, which summarises the expenditure in each department into: (1) Wages and materials expended on stock or customers' orders; and (2) Other expenditure, such as repairs, supervision, and similar indirect items of expense.

Having obtained the total of indirect expenditure for any shop, there are several recognised ways of establishing a ratio or proportion between the value of work done in a given period, such as a month, and this indirect expense. This ratio may be established as a percentage on wages, or expenses may be divided over the numbers of hours worked, or they may be distributed in some approach to a differential method of treatment by means of machine rates varying in value. Each of these methods must be considered in detail.

The Percentage-on-Wages Method. Where any attempt is made to distribute shop charges over work at all, this method is the one most usually employed, at any rate in Great Britain. The probable reason of this is that, though capable of considerable refinements, it is as usually employed a "handy," or in other words a rough-and-ready, method. In order to distribute shop charges on this plan, all that is necessary is to obtain first, the total of charges; second, the total of wages on actual orders during, say, a month in each case, and—find the percentage of one to the other. Thus, if in a given month we have spent:

ITEMS.	WAGES	MATERIAL	TOTAL
DIRECT EXPENDITURE ON ORDERS.	100	56	156
Shop Establishment Charges :			
Repairs and Maintenance............	15	4	19
Spoiled Work.........................	2	1	3
Supervision............................	5	..	5
General Labouring	7	..	7
Share of Storekeeping, Timekeeping, Etc.	..	..	8
Proportion of Rents, Rates, Power, Light, Heat, Etc., for this department	..	..	17
Total of Shop Charges.................	29	5	59
Total Wages and Material in Shop.....	129	61	..

We find that as against £100 direct wages on orders, we have an indirect expenditure of £59, or, in other terms, our shop establishment charges are 59 per cent. of direct wages in that shop for the period in question. This is, of course, very simple. It is also as usually worked very inexact. It is true that as regards the output of the shop *as a whole* a fair idea is obtained of the general cost of the work, that is of its works (or No. 2) cost. And in the case of a shop with machines all of a size and kind, performing practically identical operations by means of a fairly average wages rate, it is not alarmingly incorrect.

If, however, we apply this method to a shop in which large and small machines, highly paid and cheap labour, heavy castings and small parts, are all in operation together, then the result, unless measures are taken to supplement it, is no longer trustworthy.

The reason why, under these conditions, it is no longer to be regarded as a scientific method is not far to seek. The case of the difference in the value of work done on different machines as regards one item alone, viz., the interest factor, has already been alluded to. But this is not the only point of differentiation. The space occupied by machines varies, the power taken by them varies. And in the case of men at high and low rates of wages, the cheap man takes up as much room as the expensive man, and probably takes much more supervision; large parts, again, use powerful cranes and occupy the time of labourers in their progress about the shops, to say nothing of the room required for their evolutions.

Now on the simple percentage plan, it is not only that these factors of difference are ignored, but the basis actually used for the distribution of charges, viz., the cost of the job as measured in shillings or dollars, though apparently a "natural" one, is really quite arbitrary and without any real relation to the actual problem.

That this is so will be allowed when it is considered that the effect *in the costs* of lowering the wages rate of a man, is also to reduce the amount of establishment charges which gets allocated to the job by the system of percentages. If this represented anything like the facts it would not be so bad; but unfortunately, the highest probability exists that by substituting a poorly paid man for a good man on any particular job, the true proportion of charges would be actually increased. He would take longer for one thing, yet as his longer time occupied is counterbalanced by a smaller total of wages, the percentage would not be increased. Again, he would probably absorb more of the foreman's attention, but this would not show in the accounts. In short, the result of the change would really be to increase the cost of the work—the works cost—but the apparent effect would be to reduce it, because the prime cost might be reduced, and the burden of the charges which were before allocated to that job would fall on other jobs with which it has nothing to do.

In certain kinds of businesses it is possible to apply a compensating arrangement. Where the class of work is fairly steady, and the bulk of the work done in any one shop is on different parts of the same kind of machine, certain carefully considered but still to a large extent arbitrary variations of the incidence may be arranged. The work may, for example, be divided into three or more classes according to size of castings, such as heavy, medium, and light, the percentages being so adjusted that the heavy class takes x per cent. more than the medium class, and the medium class y per cent. more than the light class. By this means the whole of the shop charges are distributed as before over the wages expended on orders, but not uniformly. The heavier work gets burdened more heavily than the light work, and therefore absorbs more, while the light works absorbs less than it would have done without this compensation.

The method requires, however, very elaborate and careful arrangements for determining: (1) The basis on which to divide the ratio of percentages, and (2) An equally close consideration of every article manufactured to decide in which class it should be included. Where this is done the method gives satisfaction; but it should not be forgotten that anything like hasty or careless dealing with the varying factors vitiates the value of the whole method. But with proper precautions it is a very convenient and elastic system, if confined to shops which fulfil the conditions above stated.

The Hourly-Burden Plan. The broad principle of this method, in all its varieties, is based on the consideration that the shop as a whole may be considered as a factor of production, and can be charged for at an hourly rate against the work done on orders. The standing charges, the cost of maintenance, and the shop organisation, are summarised as for the percentage plan, but the resulting figure is dealt with quite differently. Instead of spreading the shop charges over the cost of individual jobs, as measured by the direct wages spent, these charges are spread over them according to the number of hours during which work has been done on them.

ITEM.	WAGES.	MATERIAL.	TOTAL.
Total of Shop Charges. (As before.)	29	5	59
Total Hours Worked on Orders During Month—3,000 Hours.			
$\frac{£59}{3000} = 4.7d$ per Hour Worked.			

Thus, if we have £59 as before, representing the whole of the shop charges for one month, we require to ascertain the time actually worked reproductively, that is on orders, and reduce this total of £59 to a rate per hour on such reproductive time. There are variations of this method, but the principle is the same in all, viz., making an hourly charge for the shop organisation and expenses.

A little consideration will show that this method may produce quite a different works (or No. 2) cost from the same set of figures arranged on the percentage plan. It is claimed by the advocates of the hourly-burden method that it is far superior, in that a nearer approach to the real conditions of work, i e., to *facts,* is realised by making the hour rather than the dollar or shilling the basis of distribution. Some of the obvious faults of the percentage system are undoubtedly removed by it. The elimination of wages as the basis of distribution certainly removes the great reproach of the former system, viz., that it makes the works cost on any particular job slavishly follow the prime-cost figures, and therefore tends to make cheap labour bungling over a job for an unnecessarily long time appear profitable. It brings into full prominence the essential fact that to have work hanging about is a costly proceeding, however low-priced the actual labour may be. Perhaps this is the most important feature of the method—it contributes to a clearer view, to more exact picturing, of the immense importance of the time factor in production.

But when we consider the system as fulfilling the role of a scientific method of apportioning establishment charges, it is easily seen to fall short of perfection in a serious sense. Just as the percentage method stakes all upon the single factor of wages, so the hourly-burden plan stakes everything upon the single factor of time. The mere statement of this peculiarity is sufficient to show that we have here a method which sacrifices a great deal for the sake of simplicity. To take one item alone, no discrimination between large and costly and small and cheap machines is brought into play. Simplicity is a good thing, but as an end in itself is worth nothing. What is required is an exact method of apportioning establishment charges, a method which will allow us to obtain figures which are closely approximate to facts, because they follow the actual and known conditions obtaining in the shops, as far as we know how to make them. If any method fails to do this, when it can be done in greater degree by another method, its simplicity is nothing in its favour. At the same time, it may be allowed that for particular conditions the hourly-burden plan will give satisfactory results. In shops, for example, where there is uniformity in the class of machines employed and in the kinds of work passing through, the simple hourly burden gives substantial accuracy. These, it will be observed, are also the conditions under which the percentage plan has been stated to be applicable. The reason of this is not the similarity of the two methods, but because in such cases, *the conditions are at a maximum of simplicity*. In other words, where we have a simple set of facts to represent, their representation is an equally simple matter.

We have here an important key to the discussion of the suitability of any system. Almost any method will represent simple conditions. But will any given method break down when the conditions become complex? This is the touchstone. As work is not arranged to suit methods of record, but *vice-versa*, it is evident that we must seek a method capable of recording with approximate accuracy under the most complex and difficult conditions. We may then feel quite secure that it will also record simple conditions in a simple manner. It is putting the cart before the horse to consider the simple matters first.

The Machine-Rate Method. This is perhaps the oldest and most widespread of all. It is not a modern method. By this is meant that it belongs to a former period, in which the close accuracy, the monthly balances and other refinements of accounting had not been heard of, and that therefore it cannot be considered as among the scientific systems of distributing shop establishment charges. In fact, it does not usually pretend to deal with shop charges, in the general sense, at all. The usual function of the machine rate is to burden the work with a charge proportionate to the interest on and the wear and tear of the machine. As usually arranged it is an hourly charge, based on the probable life of the machine under full work. In this sense it is intelligible. But cases do exist in which it has been attempted to make it represent more than this, by increasing the amount arbitrarily, so as really to charge part of the shop expenses through it as well. This is exceedingly bad practice. Why it is bad will be seen presently. The machine rate may be looked upon as belonging to the Silurian epoch of shop accounting. It is the ichthyosaurus of expense systems. It attempts to do in a heavy, blundering way what is hardly worth doing at all. Considered in its legitimate aspect—as a means of distributing the burden of interest and depreciation on any machine over the work done on that machine—it does this successfully under one set of conditions only, viz., if such machine is never, for a moment, idle. This being its condition of maximum perfection, it follows that the greater the proportion of idle hours, the less-accurate will be the results obtained from the method. A little consideration will lead to the conclusion that, in a slack time, the work done in the shops will be receiving just the same burden as in a busy time, with every machine running full. The balance of expenditure not allocated to jobs is just lost sight of.

This is a serious enough matter if we consider the machine rate as a charge for interest and depreciation only. But if we look on it, as is sometimes done, as a medium for distributing some (unknown) fraction of the shop charges, the absurdity of the method will be obvious. It will not compare for this purpose with either the percentage plan or the hourly-burden plan. Yet with all its impossibility as a modern system, the machine rate has certain practical advantages, shared by no other method. It *does* take into account just what is missed by the former systems, viz., the variation in the cost of work done on different types of machines. This feature, which practical instinct easily recognises, has secured its survival. Though it cannot be considered as a good method, it has had its value as a compromise between bare prime cost and a regular apportionment of charges. It tells something definite—something which is valuable, but which is neither as definite nor as valuable as it might be.

The fact that it establishes a permanent relation between the work and the machine is a valuable feature. By a permanent relation is meant a relation which does not change or fluctuate with conditions of work in the shop. The charge for the machine being always x, whether the shop is slack or busy, brings a very steady factor into account which is available as a datum of comparison between work done at different periods as no other factor is available. The prime cost, for instance, is no absolute guide for comparison of efficiencies, since rates of wages vary not always in direct proportion to personal output. The shop charges on the two former systems also fluctuate violently, but the machine-rate value remains constant. This is because it is a pure function of time. It is true that for all practical purposes the time itself is the very factor which it is desirable to know. And remembering this, it is not difficult to see that we can obtain this information without necessarily being bound to a non-fluctuating charge.

General *Résumé* of the Foregoing Methods. There have now been passed in review the three fundamental methods of allocating shop charges over work so as to produce works (or No. 2) cost. Of these only the first and second give a real No. 2 cost in the sense that *all* the charges for a given period are spread away over productive work.

It will have been seen that there are two distinct ways only of doing this. The charges must be distributed either on "wages value" as a basis, or on "time occupied" as a basis. For ordinary manufacturing operations there is no other alternative. In certain special industries a distribution on units of weight or measure might be necessary, but we need not pause to consider these. Generally speaking, we have to choose between wages value or time as a unit on which to distribute.

The weak point of the percentage and the hourly-burden system is that it is an *averaged* result at which we ultimately arrive, and which we try to regard as the true works or No. 2 cost. Now, it is just as wrong to average such charges as it would be to throw all wages paid into one sum, and average this over the number of hours worked, taking the result as a true wages cost. In the case of wages this is seen to be an absurdity, and no question of simplicity or convenience would be allowed to stand in the way of collecting the actual wage cost of each job in an engineering works. An average-wages charge is easily seen to be misleading and dangerous.

Yet in certain cases where only one class and size of article is turned out in one shop, this averaged-wages cost, although several variations of rates may be included in the total sum before averaging, is not only useful but is actually used. It works successfully in such cases because of the extreme simplicity of the conditions. Only one set of factors being concerned, viz., a single process and a single variety and size of article, the averaged charge for wages sops up inequalities of rates, which inequalities are not due to exigencies of manufacture but to exigencies of employment. Here we have an excellent example of a method of accounting, correct within narrow limits, but obviously breaking down the moment those limits are exceeded. The impropriety of applying such a system of averaging wages to a shop in which several processes, different grades of workers, and separate sizes and classes of articles are concerned needs no argument. It can be realised at a glance. But this case of wages is exactly on all fours with the case of shop establishment charges. Under very simple and uniform conditions, a method of distributing establishment charges which averages such charges per shilling of wages or per hour of time is correct, but in proportion as we depart from these simple conditions we also depart from accuracy.

This is not a mere theoretical and pedantic distinction. These shop charges frequently amount to 100 per cent., 125 per cent., and even much more of the direct wages. It is therefore often actually more important that they should be correct than that the actual wages cost should be correct. If we have to put sixpence and also ninepence in a certain collecting bag, it is certainly more important that the ninepence should not go astray than that the sixpence should be looked after.

It is true that by no possible method can we avoid averaging shop charges to a certain extent. But we can reduce this extent to a minimum, thereby attaining a high average of accuracy. In the end we have, of course, to choose between one or other of the alternatives already mentioned, viz., wages or hours, for the distribution. Yet by avoiding the attempt to force simplicity of results into the representations of conditions which are by no means simple, and by letting our method follow the natural lines of the actual complexity, we can arrive at results which are no longer averaged to anything like the same extent, but are on the contrary highly differentiated.

The Elements of an Ideal System. A little preliminary consideration may be given to the features which might be looked for in an ideally perfect method of inter-connecting establishment charges and work. Having entirely cleared one's mind of any traditions of what is usual or conventional under the averaging *régime*, it becomes visible that several of the items of shop charge are naturally connected with the use and employment of property or plant, and are in the nature of a rent paid for these. In this category are:—Rent, taxes, and insurance on buildings, interest, depreciation on machines, on cranes, shafts, motors, etc. Other items are connected with other factors of production. Power, with the use of same by machines; cost of lighting or heating, with area of floor space usually lighted or heated—in short, not to go into detail at this stage, it is readily seen that a large number of shop charges are by no means general in their real nature but can be narrowed down to definite points of incidence.

In an ideal system, it would therefore be expected that this narrowing down should be carried as far as it was practically profitable to do so, and that only such expenses as were wholly general and could not by any reasonable analysis be connected with definite points of incidence, should be treated as general shop charges, and therefore left to be averaged on the former basis. This looks complex. And undoubtedly under the most favourable circumstances the preparations *are* complex; but, as will be seen, a working method (which after all is the only thing in which simplicity is important, or at any rate essential) can be devised which is not more troublesome than other methods of distributing shop charges. Before going on in the ensuing articles to explain in detail the preliminary steps and the methods of working, an idea of the new point of view on which the method advocated is based will be given.

We have seen that it is a very simple matter to represent the conditions of a shop in which the work is uniform and all the conditions constant. All the charge factors, whatever their real point of incidence, press equally on all portions of the work in such a shop, and there is therefore no differentiation between different portions of the work possible. In a mixed shop, on the contrary, these factors do not press equally,—power, floor space occupied, with its burden of rent, interest, insurance, lighting, etc., interest on capital outlay for machines—all vary as between jobs. There is no justification for treating such charges as an average if it can possibly be avoided. Hence it is evident that in the distribution of such charges the shop can no longer be considered as a unit, but something smaller must be taken. Of course, to subdivide the shop into smaller areas would be no solution of this problem. The mixture of the factors of incidence would be as great in half a shop as in a whole shop. A new point of view is necessary.

It becomes desirable to look at what the expression "shop" really signifies. If we regard the shop as an organic whole (which it no doubt is, or should be,) we get no new light. We may perceive clearly enough the cross-fire of factors of incidence bearing unequally in different parts of it, but are no nearer their disentanglement. But if we regard the shop as a collection of small "production centres," each differing from the other, with certain common connecting bonds which are alone the average or general factors of incidence, then the problem suddenly becomes clear. If, instead of turning our energies to cover up the natural differences between these "production centres" and make an average of them, we devote our attention to giving the fullest play to this difference, we may claim to have subdivided the shop in a new sense, and to a new end.

A production centre is, of course, either a machine, or a bench at which a hand craftsman works. Each of these is in the position of a little shop carrying on one little special industry, paying rent for the floor space occupied, interest for the capital involved, depreciation for the wear and tear, and so on, *quite independently of what may be paid by other production centres* in the same shop. Then, in addition to this, there will be a separate debit representing those items of incidence which can only be treated as an average all-round charge. The cost of each production centre is, of course, laden onto the work by a rate per hour. Here we seem to have come back to a machine-rate method, subject to all the defects of that method, particularly as regard the idle hours. If the new process ended here it would be of little use, but it does not end here.

It will be seen, when this portion of the subject is reached, that whilst the rate for the production centre is kept constant, the waste of resources due to idle production centres is not lost sight of, but finds its due place in the works cost simply enough, and in such a way that it has a special significance of its own.

One prominent advantage of the plan of reducing each shop to its constituent production centres as a basis for distributing establishment charges should be noticed. The most heterogenous processes may be carried on side by side. Having narrowed down the greater portion of the shop charges to their fundamental points of incidence, we need no longer be afraid of any conditions, however complex. Unlike the averaging methods, almost any actual working conditions can be faithfully represented on this system. This is because each production centre is virtually independent of any other, and therefore complexity is indifferent to it.

It will be seen, for instance, that it is applicable to heavy engineering work, to mass production, and even to that most complex class of work, in which almost-automatic machines work side by side with ordinary machine tools.

THE MANAGEMENT AND CONTROL OF THE COLLIERY.

By William Blakemore.

In a preceding article, Mr. Blakemore reviewed the broad scope of the colliery manager's duties underground. He now takes up the control of the hoisting and surface arrangements, which display in even greater degree the comprehensive mastery of mechanical appliances, labor management, and organizing ability demanded of the modern mine manager.—The Editors.

HAVING reviewed briefly in a preceding article the matters which claim the attention of a colliery manager underground, we pass to a consideration of the hoisting and surface arrangements. On the latter subject little need be said, because practically the direct hoist has not been superseded. Various methods of applying a balanced weight have been tried. The only one of any importance is that resorted to in the Koepe system, which has a return rope from the under side of the cage; but without entering into details it is safe to say that this need not be seriously considered at present. As to whether a steam or electric hoist should be used depends upon whether a natural water power is available for generating purposes. If so, it has been amply demonstrated that whether for a single large mine or a group of mines, it is economical to generate electrical power at a waterfall and to distribute it from one central station. It will pay to do this for a number of mines when steam has to be resorted to for generating electricity. On all grounds it is cheaper and more efficient to have a central station than to attempt to set up a number of individual electric plants at the several mines. If steam is used, it may be said that the day of low pressure has gone by, and that the best type of boiler is the water-tube, with working pressure of 180 to 200 pounds. Geared engines are going out of use as large outputs are becoming the order of the day, and there is probably nothing better in ordinary cases than coupled engines with automatic cut-off and a piston speed of 250 to 400 feet a minute. For hoisting from great depths and with a large load, the most recent development is in favor of compound condensing engines, and where the extent of a mine warrants the outlay the manager gets the finest hoisting plant obtainable in this. Conical drums, grooved to suit the ropes, are being used, as they are easier on the engine at starting and stopping. The guides in the shaft should either be wire ropes with tension weights or steel rails bolted to the buntons, and as a matter of course for the rope working in the man shaft a safety detaching hook will not be forgotten.

The most important thing in connection with surface works is the general lay out. Commencing with the railroad tracks, these should be set on a grade of 0.60 per cent. if straight or 0.75 per cent. if curved. There should be as many parallel tracks at the screen house, or at the foot of the breaker, as qualities or sizes of coal to be loaded, and the grades should continue below the loading point so that when once cars have been pushed up to the top of the "grid-iron," as this series of tracks is well called, they will fall by gravitation to the point where the outgoing train is made up. Where this arrangement can be carried out no locomotive nor even horse is required upon the surface railroads.

In the case of a screen house, which is required generally speaking where domestic trade is done and the coal is to be divided into a number of sizes and qualities, the elevation above tracks need not exceed 30 feet, and the shaking or oscillating screen with reverse shoots will make three or four qualities, say large coal, nut, egg, and fine. Where the coal contains an admixture of shale, stone, or other impurity, a picking table will be necessary; this may either cross the tracks at right angles or run over them on parallel lines. In the case of hard coal or coking coal which does not require to be picked, the elevation and the tracks require to be arranged upon a different principle. The breaker will be at such an elevation as to allow of a bin being constructed below to hold whatever quantity of coal may be desired, from which supplies can be drawn to the cars from underneath. Such bins vary in capacity from 1,000 to 5,000 tons, and are a great advantage in cases of break-down or accident of any kind which hinders the output. Where it is not possible to make the adit into the mine at the same elevation as either the screen house or the breaker, a conveying plant will be necessary. The most favorable condition, however, is where the grade of the level entering the mine can be continued to the point where the coal is dumped. Even so apparently trifling a matter as the choice of a tippler will have an important bearing upon the efficiency of the screen house, as nothing is so apt to cause delay as a poor tippler. The feature governing this is, of course, the tonnage required to be passed. The most efficient for a large tonnage is one in which the tub after emptying runs through the tippler and is returned to the haulage track by means of an elevator or creeper. This method avoids the delay incident to drawing the tub back, and enables as much as 2,000 tons a day to be passed over a single tippler. If the coal is required for coking purposes and contains impurity, especially sulphur, it may be necessary to resort to a washer. This should be erected near the screen house, and the fine should be carried from the screen in a conveyor. The effect of a good washer is very pronounced, and has resulted in the conversion of an inferior, unmarketable coke into a first-class article. It is possible to reduce the sulphur by at least 50 per cent. and ash by 75 per cent.

Where coke ovens are used it is an advantage to build them as near the mine as possible, without, however, coming so near that the latter will be affected by the smoke and sulphur passing with the ventilating current; a distance of 1,500 to 2,000 feet will generally obviate this. In some cases it is practicable to carry the coal by means of a conveyor direct from the breaker or washer to the coke ovens. Failing this, the simplest method is to haul special hoppers direct from the mine over the ovens and charge them from the track. Where this cannot be done, owing to distance or other considerations, there should be a high-level and low-level track at the ovens, and a storage bin between the two, the bin to be charged on the upper track and to feed a lorry for charging the ovens, which may be worked either by electricity or steam.

A good manager will want to see upon his plans exactly what is going on in the mine, and this necessitates the employment of a competent surveyor who will keep the plans well up-to-date, not relying in the slightest degree upon the magnetic needle for his underground work. An up-to-date plan will show, by some distinguishing means, haulage roads, air ways, water courses, working places, faults, with their direction and rise or dip, the inclination of the strata, the level of various points in the roads and workings from a given datum, the thickness of the seam at different points, especially noting any variations and the date of the last survey. In addition to this the manager will require an estate plan showing the surface of his property with all buildings, erections, and water courses marked thereon, and a third map showing generally the contour of the surface, so that he can easily determine the thickness of the overlying strata at any given point.

The foregoing article treats of the relation between the manager and his work. There is space to refer only briefly to his relations with his employers and with his subordinates. The former will expect periodical reports, which should be full, explicit, and lucid. They will partake of a threefold character—technical, financial, and advisory. The former will give particulars in detail of the works in progress in all departments, with special reference to construction work and contemplated new developments. The second will furnish items of cost and will deal generally with the finances of the mine. The designing of a good cost sheet is one of the most difficult tasks which a manager can undertake, and although it may appear to be rather the work of an expert accountant, it must really be the production of the two, because every manager worthy of the name has his own ideas, and can import valuable features into a cost sheet which the man of figures is ignorant of because he is not a practical miner. An ideal cost sheet shows at a glance the cost in each department, the cost of each separate operation in connection with mining, the cost of surface as distinguished from underground works, the cost of material as distinguished from labor, and the cost of motive power distributed over the various departments which use it. The advisory report partakes of the personal and should give in a clear and concise form a review of the work since the previous report, with recommendations for the future, and in this the manager should always be careful to prepare his employers for any impending difficulty, whether in connection with the mine or the workmen.

There was a time when employers were apt to treat mine managers very cavalierly. That time has gone by, and today the relations existing between them are as a rule of the most satisfactory character, due largely to a better appreciation of the responsibilities and dangers of the calling, and largely to the fact that the urgent necessities of mining developments have produced a better class of managers whose abilities entitle them to respect.

The mine manager is well-advised to insist respectfully but firmly upon a free hand, and to refuse to allow directors or employers to interfere with him in matters of detail, or to make themselves too prominent in connection with the affairs of the mine. Their duties should cease when they have determined the policy and given their manager general instructions. It rests with him to carry them out, and if he fails to do so they can get rid of him; but the manager who tolerates interference is signing his own death warrant both with his employers and his workmen. The results which mine owners expect from their manager can be achieved only by a thorough system of organization carried out with consistency and singleness of purpose.

Although the important works referred to above have to be carried out by other men, he will have to design them and will therefore require to exercise the wisest discrimination in the selection of his subordinate officers, and if he allows any other consideration than that of absolute fitness to weigh, he will be the greatest sufferer in the end.

In the case of a large mine every manager should have an assistant, to share not his responsibility but his work, and such an assistant may be a young man, fresh from a mining college, who, whilst acquiring practical experience necessary to fit him for his career, will furnish just that kind of help which a manager most stands in need of, and at a moderate salary.

The next requisite is a thoroughly efficient and experienced under manager, who will spend the whole of his time in the mine and supervise every department, reporting promptly to the manager on any matters of importance coming under his notice.

Each section of a mine should have an "over man," as, however efficient the workmen may be, it is found in practice that it pays to have a "boss" in every separate section, not merely to see that the men do their duty but to handle promptly and effectively any of the thousand-and-one difficulties that are continually cropping up.

Examiners of working faces and shot firers should be also steady experienced men, and in this department in particular the question of character is highly important, because the duties of the position are so intimately associated with the safety of the men. It has been found advantageous to have one or two road examiners, whose duties are confined to supervision of the tracks and calling the attention of the road gang to any defect which they discover.

Upon the surface there should be a foreman at the screen or breaker, and where there is a coking plant a day and night foreman at the ovens. In addition, whether there are machine shops at the mine or not, a thoroughly practical mechanical engineer is necessary, who should have at least a small fitting shop to do repairs. His hands will be full in seeing that the machinery is in running order and that the wheels are kept turning.

In the case of electricity being used for any purpose an electrical expert is necessary, in consequence of the liability of all electrical appliances to get out of order. The manager's office should be at the mine, and whilst insisting upon the various heads of departments doing their own work, and doing it thoroughly, he should see for himself by frequent visits inside that his instructions are carried out, and by thus coming in contact with the workmen, he will, if a reasonable and diplomatic manager, gradually acquire a personal influence over them, which will not be without its value when matters of dispute arise.

The manager who thoroughly understands and has well organized his work, however large the mine, can sit in the office with his finger upon the pulse of every department, and know by the series of reports which should be placed upon his table every morning, exactly what has been done since the previous day, what the output has been, what accidents if any have occurred, what hindrances and the cause, what workmen have been absent, what material has been sent out of the warehouse, and what the actual cost of production has been within the previous twenty-four hours.

In these times of excessive competition and of such low costs as were not dreamt of even a few years ago, all this is necessary if a man would be master of his work. It can be done, and done easily, if everything about the mine proceeds upon a method; and when it is done, although the anxieties, responsibilities, and risks of the calling are probably heavier than in any other, unless it be that of the mariner, there is compensation in the satisfaction with which a colliery manager can regard the successful discharge of such multifarious duties, which makes him of all men the most devoted to his calling and the most unwilling to exchange it for another.

REPETITIVE SHOP PROCESSES AND INTERCHANGEABLE MACHINE PARTS.

By Barton Cruikshank.

The genius of modern mechanical progress has three great attributes—specialization, standardization, intensification. These represent the natural development of the use of power and machine processes, and it is by moving freely in accord with them that the United States and Germany have made so marvellous an industrial advance.

Their characteristic manifestation, in the field of mechanical production, is the transference of almost all functions demanding skilled manipulation, high accuracy, and tireless energy, from the mechanic to the machine. The operator becomes not merely a dexterous manual workman but a trained intelligence, supervising the materialized intelligence of the designer as embodied in the tool. And with these new machines should go new methods, similarly designed to eliminate the "personal equation"—the varying individual weakness—of the workman. It is with such methods, applied to the small shop, that Mr. Cruikshank deals.—THE EDITORS.

VERY naturally, the details of the management of any individual shop working on the interchangeable plan must, of necessity, vary with the work, and even in the same lines of work it will be different in different parts of the world owing to social and other elements; but all shops, whether manufacturing a staple article or doing job work, whether building light or heavy machinery, should be organized and run in accordance with a few fundamental rules. There are undoubtedly others than those I shall formulate which would be applicable to all shops; these, however, are certainly such as would, on a moment's thought, occur to anyone.

First:—The draughting room should be managed according to some simple rules, such as:

(a). All work made in the shop must have a record filed, either as drawing, or sketch, or written description.

(b). No drawing shall leave the files without, in some way, having been charged to the person taking it.

Second:—There should be a tool room, in charge of one man and with some such rules as these:

(a). No workman, except the assistants of the one in charge of the tool room, shall have unrestricted access thereto.

(b). No tool shall be drawn except in exchange for the workman's own check.

(c). No tool check shall be returned to the workman until the tool for which it had been exchanged has been examined and tested by the tool-keeper.

Third:—No workman should start on a new piece of work without making record of the time spent on his last piece of work.

Fourth:—A system of book-keeping should be arranged for each shop, whereby by noon of each day the cost of each piece up to the evening before could be quickly and intelligibly ascertained.

Fifth:—There should be a stock room from which stock could be drawn only on a special blank provided for the purpose.

Sixth:—A constant inventory of stock should be kept by entering daily the blanks above mentioned, and a daily report should be made to the superintendent when the amount of stock on hand falls below the amount decided upon as just sufficient to carry the demands until new can be secured.

In considering more specifically these rules, I hope to be pardoned for citing some of my own experiences, trying, from them, to point out general principles and methods.

Nine or ten years ago I took the superintendency of a works where they were turning out over 3,000 machines a year, supposedly with all parts built on the "interchangeable" plan. In this shop there were no drawings of the machine, nor of any of the special tools used in its manufacture, nor were there records of the exact sizes of the different "stock" used in its construction. Each contractor had gauges and worked to them for his own convenience, but there were no standards with which to compare these gauges so that, by changes of from one to four thousandths, caused by different rates of wear in the different gauges, each contractor had come to have a size of stock which he demanded, but which differed but very slightly from some other used in the same machine; none of these sizes corresponded with any standard used by the manufacturers. By making record of all the sizes, and taking some standard size near each of the groups of those sizes which seemed originally to have been the same, it was possible to cut down the assortment of stock to about one-half the number of kinds carried before this system was started. To insure an accurate and constant knowledge of standard sizes, therefore, the model shop should have in its draughting room a system by which, in a moment, any drawing ever made or used in the shop could be found.

To go into details on the subject of care of drawings may seem to some superfluous; but my experience has shown me that many shops do not know the true value of a well-arranged file of drawings, or, knowing the value, have not the skill or perseverence necessary to carry out a successful plan. Methods must, of necessity, vary with the different shops, but slight changes worked upon the one I have successfully used would, I think, make its best features available for almost anyone. In the first place, all my drawings had to be on one of three standard sizes. For drawings of special tools or of machines of which we should probably build but one or two, we used a yellowish paper mounted on heavy straw-board. After the drawing had been inked with waterproof ink, it was given a coat of white varnish before being taken into the shop. The upper left hand corner had the "catch number" and the name of the tool or machine. Drawings much to be used were made on the same mounted paper, but were left in pencil and tracings were made from these. For filing, the tracings were fastened to the pencil drawing with a paper clip. The blue prints also were varnished and were mounted as above described on heavy straw-board. Each board had a ¾-inch hole in the middle of the top margin, and each workman had directions not to handle his drawing with greasy hands but to leave it hanging on the wire provided for it over his bench, to report to the superintendent if any dimensions were missing, and never, under any circumstances, to "scale" the drawing.

For filing, cabinets made in different sizes to fit the different sizes of drawings are necessary. The small size takes all standard octavo catalogues, all papers from the American Society of Mechanical Engineers, and all index cards referring to numbers of drawings or other desirable memoranda. For clippings, manila envelopes, 6½ inches by 9½ inches with Acme library card pockets mounted on them are used. The catch word is placed upon the envelope and the cards are placed in the pocket. Should the catch word of a new envelope come between some of the cards already in a pocket on one of the envelopes, those cards ranging alphabetically before the new envelope would be put into the pocket on it and both envelopes and their respective cards arranged alphabetically in place. In very large works where the catch word would be at all apt to lead to confusion or the oversight of an article, the Dewey decimal system, now so much used in public libraries, might perhaps be employed to advantage. The same style cabinet, but larger, works admirably for drawings mounted as above described. Our drawing tables had an edge of hard wood projecting the thickness of the straw-board above the table to enable the T-square to work smoothly.

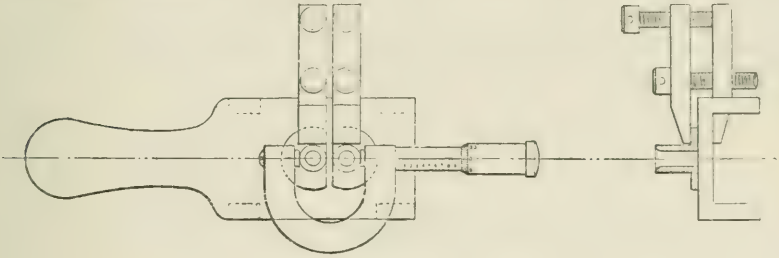
The Tool Room.—Anyone who has been long in a shop where there was no tool room is fitted to judge as to the amount of time wasted in hunting for tools with which to begin the work. Does it not often, in such a shop, take longer to hunt up the proper size of tap drill and then to find the drill than to drill the hole and tap it? But in the properly laid out tool room, the taps and the tap and body-size drills all lie in correlated compartments of the same shelf or drawer; one check draws taps and tap drill, a second check being necessary to draw the body-size drill or the bottoming tap. This homely illustration does but show one of the hundred other like experiences that a day's comparison of two such shops would bring forth. And the tool keeper, if a trusty, clear-headed man, can keep busy, even in a small shop, to the decided advantage of the profit side of the balance sheet, even if he does nothing else than keep thoroughly in repair the regular and special tools of the shop, though often he may be able advantageously to work on new tools or other regular work of the shop, his tool-room necessarily being fitted with the best lathe and universal grinder purchasable.

In the tool room are kept not only all the standard tools, such as taps and drills, reamers, arbors, etc., but also the special tools. A discussion of the many different styles of these, as they are now used in the best shops, is not possible in this paper, though future descriptions of such by others working on these lines, will, I hope, be the result of this article.

Since two or three makers of turret lathes have added to the range and variety of work possible by dropping the old turret form and substituting a horizontal face plate with its wide range of motion and position for its special tools, the catalogues of the makers of such lathes have become, in themselves, text books on machine design and shop organization. The drill jig, the milling-machine fixture, the shaper and planer attachments, are, however, seldom described. Each shop has its own peculiar style, and but few men have opportunity to make a comparative study of even general types. One thing, however, is common to all shops making repetitive parts. This is the drill jig bushing. I shall insert here an article of mine presented at the New York meeting (December, 1893) of the American Society of Mechanical Engineers, and forming part of Volume XV of the Transactions, only regretting that I am unable to give also the several valuable additions to our literature on shop practice which immediately followed.

"The following simple plan is submitted as leading to good results in the making of drill jigs. This is a well-known device in some shops, but, not being universally used, a brief description of it would perhaps be of interest.

"Where two holes are to be placed in the jig in the same flat surface, at a given distance from centre to centre, they can be quickly and accurately located by the use of hardened-steel bushings ground to a known size on the outside, and lapped out to fit very accurately the drills and reamers which are standard for the tits of counterbores in use in the shops. By using the same tit size for several sizes of counterbore, the number of bushings necessary for all round work could be considerably kept down. These bushings should be made with a flange or other projection, so that with clamps they may be temporarily fastened to the jig, as shown in accompanying sketch, the distance from the outside of the one to the outside of the other measured with micrometer or vernier caliper, and the holes for the counterbores drilled and reamed.



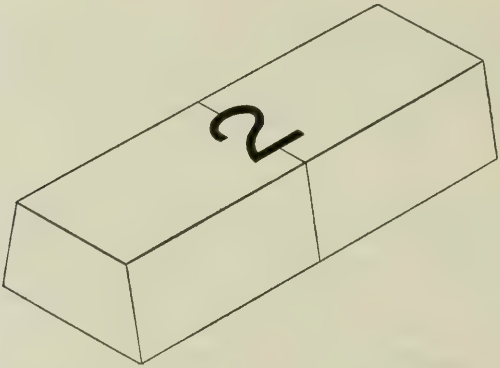
A DEVICE FOR DRILL JIGS.

Reproduced from the Transactions of the American Society of Mechanical Engineers.

"This is not new nor my own device, but is so handy that it should be more commonly used in shops where sufficient jig making is done to warrant the expense of the few bushings with counterbores to fit."

The special-tool designer has indeed a broad field in which to exercise his powers, and the tool-maker has oft-times jobs which to the layman seem impossible—such, for instance, as the set of tools for the manufacture of the automatic bank-check punch, which I cite not only to show a sample of the kind of article which should, I think, be written as a sequel to this, but because the methods used in its construction, in addition to being models of good tool-making, were examples of far-seeing, systematic shop management. The tools were made in duplicate and one set sent away to the safe-deposit vaults, but their painstaking did not stop with these efforts to insure against losses, errors, and changes. This will be seen from a description of the making of one of the punches and dies—say for the figure 2. First a two-piece die was made, fitted into a die holder or bolster, and hardened and lapped so that it was as perfect as tool-maker could make it.

Next a steel punch was made to fit into this, and a duplicate die made to fit the punch. This punch and the second die were used to make the dies used in the machine proper. These dies are made of discs of thin tool-steel, and can be seen in almost any bank on the machines themselves. Die number one was then taken apart and a lathe tool was made to fit each half. With these lathe tools, milling cutters were made. Then a drill jig was made in which to drill the ends of the rods used for the punches in the machine itself, the hole drilled forming the inner circle of the figure 2. Then two fixtures were made to hold this same piece of stock in the milling machines where the above described mills did the forming of the rest of the figure 2. The finished machine punch thus made must fit perfectly into the original die to which were fitted the lathe tools which formed the milling cutters which made the punches. From this it can be seen that accuracy of workmanship is the first essential, taking it for granted that we must have a good design.



After the many able papers on cost-keeping—on book-keeping for the shop—which have been placed before the members of our engineering societies and the readers of The Engineering Magazine, it would seem like presumption for me to speak on the subject did it not belong properly in this place to give in the one article a rounded discussion of shop organization.

A system which will, with a minimum of labor, keep costs in handy form for a shop doing job work can, of course, be readily arranged to meet the requirements of almost any manufacturing establishment. Such a system I shall describe. In the shop each workman entered on a time card the name of the job, its number, and the time he had spent upon it, as shown on the following page.

JOHN SMITH.

Workman's
Number.
27.

February 9, 1901.

Name of Work	Order Number	Part Number	Hours
Drill Jig for Typewriter..........	1762	15	4
Repair—Lathe No. 7.............	127	7	3
Milling Fixture for Check P......	1813	7	3
			10

This slip was inspected by the superintendent and passed to the bookkeeper. His cost book was ruled in columns, so that from these slips, with the writing of little else than figures, he could give a full history of the work as shown below. The page would be headed with the name and number of the order and under the proper column, in this case the one for part 15, the entries made as follows:

Date 1901	Workman	Wages	Hours	Total	Stock	
2/9	27	32½	4	1.30	4 oz. ⅛″ x 3″ C. R. steel	.02
					2¼ lbs. tool steel	.40½
					1½ lbs. cast iron	.06

In our shops this was a regularly bound volume, but it would undoubtedly be a great advantage to use a binder and sheets that could be alphabetically arranged for each new order.

In the job shop, items for drills, files, emery, oil, waste, etc., were seldom chargeable directly to one job and were therefore kept in a separate account, and, like office expenses, rent, insurance, etc., made a constant per cent. to be added to all estimates of cost. Such items, in a shop running on regular work, could be much simplified.

In keeping a constant inventory of stock, the work was done by a low-priced clerk who subtracted from the amounts already in the columns under the various heads in the stock book the amounts shown to have been drawn from the stock room as found on the requisitions. This inventory was kept on sheets in a flexible-backed binder, so that new leaves could be inserted alphabetically whenever old ones were full or when a new kind of stock was added. At the top of the page was to be found the name of the stock, its size, its cost, and the amount below which it should not be allowed to fall before a report was made so that new might be ordered to insure a constant supply on hand.

In connection with stock keeping it may be interesting to some to know that, against the advice of several practical men, I was able, even in a large job shop, successfully to keep, not only an inventory of files but, with very little bookkeeping, an oversight upon where they went and by whom they were used. A new file could be drawn by the workman without an "O. K." from the superintendent, by presenting at the stock room his own written order and a worn-out file of the same kind. Should he need a file of a different kind, he must get the O. K. of the superintendent upon his order. The page for files was headed with the workman's name and ruled and kept as below:

Smith, John

	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Bastard, 12",	~~////~~	//	/	///	/	~~////~~	//	///	~~////~~	//	//	
Hand, 8", smooth	/	/	//	/		/		/		/		

Let me urge those in charge of shops using special tools of any kind to let the manufacturing public hear not only of the unusual but of the ordinary styles they are using. What is very ordinary to one shop will often prove to be quite new to another. Engineering papers will, I am sure, be glad to publish good papers descriptive of such tools, and schools of technology will be only too glad to find such articles to aid in fitting their students to be not old-style machinists but up-to-date men able to carry into their engineering work-shop methods that will be the integration of all that is best, drawn from the experience of the foremost manufacturers. We have no text books on design of special tools. Do we not need one? Has not the day of building without such tools gone by? Do not the machinists of the United States owe it to their country, now the foremost in the world in the use and manufacture of fine machinery for the making of repetitive parts, to do all they can to make more universal amongst machinists and engineers a working knowledge of special tools and fixtures?

EDITORIAL COMMENT

It is hard to be always an optimist. Our idols will fall at times so far below our ideals that devotion stumbles and faith falters. THE ENGINEERING MAGAZINE has been persistently hopeful for the future of organisation, whether of employers or workmen—confident that in association lay the best road to understanding and agreement—convinced that the faults of trade-unionism were chiefly in the misuse and abuse of its forces, rather than inherent in the system—and steadfast in the belief that time and trial would raise up wiser leaders and establish sound and reasonable principles for its guidance. From this standpoint the agreement of the British engineering master and workmen in 1898 and of the American employers and machinists in 1900 were hailed as a long and substantial gain in the advance to a better labour system.

It was, perhaps, too rapid to stand without a reaction. At all events, the present murmurs in Britain and the recent upheaval in the United States have shaken the quiet which seemed to be settling over industrial relations on both sides of the Atlantic.

* * *

And yet, none of these things weaken the argument for association, argument, and adjustment by mutual agreement. They merely show that there is more for the associations to do than might have appeared some months since—not at all that the associations are incompetent to do what is to be done. There is much for them yet to do, first, in educating their more backward members in sound ideas of right and wrong, of reason and justice, and of sound industrial economy; there is much to do in perfecting their organisation and discipline and the sense of responsibility among their officers and members to the point where an agreement made by the union will have the force of a contract with the individual men comprising it.

* * *

From the confused situation in the United States machine trades come several instructive glimpses illustrative of the work which intelligent unionism has before it in educating, guiding, and controling its weaker members, in instructing them in the relations which must of necessity govern commercial transactions (including the sale of labour) and in the reasonable and sane use of such power as organisation may give. The first instance is that of an "open" shop in Brooklyn and indicates the foolish tone of the small agitator whom a wise and experienced unionism would summarily suppress. The incident opened with the following letter addressed to the proprietor. For obvious reasons, all names are omitted:

> "BROOKLYN, May 24, 1901.
>
> "Dear Sir: In view of the present labor troubles and desiring to share as a body in the benefits derived therefrom; we your employees have unanimously agreed to ask you for a reduction of the number of working hours per week, from 59 to 55 as demanded by the International Association of Machinists, without any reduction of money we receive for 59 hours' work. We also hold as a grievance the dismissal of one of our number —— —— ———, for no just cause. He has done his duty as he understood it according to the orders of ——— ———, (the foreman) and he certainly should not be blamed for any error he was ordered to commit, therefore, We desire his reinstatement and also the dismissal of ——— ——— (the foreman).
>
> "Trusting that our request will be granted at your earliest convenience, and wishing you a prosperous and honorable career we remain yours very truly,
>
> "The Employees of
> ——— ———."

Convinced that the letter was the work of some small clique of malcontents, and the "error" of the fellow workman referred to (grinding down with emery a job which it was the uniform practice of the work to hand-scrape) was not attributable to the foreman, the proprietor made no immediate reply, but undertook a quiet investigation to discover the general feeling in his shop. Then followed the remarkable note appended :

> "June 26, 1901.
>
> "Sir: Several weeks ago, we the long suffering employees of your establishment asked you in a letter to shorten our hours of labor. We left it to your discretion to do as you pleased and you did nothing. Now dam you, we demand it and if we do not receive any more satisfaction than we did before, every damned man and boy in the place will go out next Saturday, June 29, and will not return or allow you to fill their places, until our demands are granted. Now damn you, put that in your pipe and smoke it, if you have one.
>
> Resp. Employees ———
> per J. W."

The proprietor thereupon promptly decided to ignore the matter, and went away on his vacation, leaving the foreman in charge. At the time of our latest advices, about the middle of July, "every (self) damned man and boy in the place" was still working. So much for the folly of unorganised labour.

* * *

The second example is of organised folly, and is found in our correspondence from one of the western States. We quote the letter *verbatim*, excepting only names :

> "In the ——— ——— machine shop of this city (Detroit, Mich.) Mr. ——— did not join the local association (National Metal Trades) when the strike came on, and after the men were out one week he agreed to their demands, so far as the nine-hour day and 12½ per cent. increase were concerned, and the men returned to work. Yesterday one of the men refused to work on a piece of work and Mr. ——— laid him off, telling him that when he got some work that he could work on he would have him come back. A committee from the union at once waited on him, and demanded that he take the man back and find work for him. Mr. ——— said he was unable to do this, and as a result they called out all of his men again. Mr. ——— is now considering the advisability of joining our local association, and at least will co-operate with us. We believe he employs about thirty men in all, and for about twenty years has had no trouble in his shop until this spring. We think his case is a good one to place before any weak-kneed members of the association."

* * *

Organisation does not of itself immediately confer wisdom, but it establishes the machinery by which wisdom may be disseminated, and through which, we yet believe, wisdom will ultimately gain the control. As Mark Tapley said, there is no credit in being cheerful when everything is comfortable ; we claim the credit of holding cheerfully to an optimistic view of organisation and arbitration, in spite of present apparent discomfiture. A keenly interested observer of industrial conditions said lately : "These questions can't be fought out ; they must be *talked* out." Strikes and lockouts lead only to forced settlements and lasting bitterness. Argument, education, conviction will lead to permanent adjustment with mutual content. And organisation and conference afford the means to these ends.

* * *

It has been pointed out often in these pages that one of the most important results from the spread of the newer system of traction and propulsion was the considerable economic change they brought about, through altering the time-and-money conditions in the movement of passengers or goods. The bicycle had a distinct influence in altering the distribution of population, and of course a much plainer one in increasing the volume of short-distance travel—rather unexpectedly, to the advantage of the railway also. Cycle-and-rail tours brought a new class of business, probably very many times as great as the business lost through the adopted use of the bicycle by former short-distance railway travellers. Next, the "trolley" played a much larger part in enlarging the radius of convenient and desirable residence near urban centres and in redistributing population in accord with the new conditions and possibilities of local transport. And now the electric tramway is beginning to play a part in goods traffic as well. In New York a special city-delivery service for parcels and general express business has been put into operation, and its freight cars are operated over the existing electric lines—the undertaking being greatly facilitated, of course, by the fact that the principal lines are now all converted from the cable to a uniform underground-conduit system.

But it is from the motor car that the largest results in improving the economy of distribution may be expected. Just a year ago this month, Mr. F. M. Maynard discussed in the pages of THE ENGINEERING MAGAZINE the advantages of motor-car service, as compared with rail, canal, and horse haulage, for transporting and delivering the product of the factory. In flexibility, convenience, and manifest adaptation to "door-to-door" service without rehandling, its case hardly needed argument; but Mr. Maynard showed further that in reliability, time, and actual money cost, the advantages were strongly with the road car. In Great Britain it has passed its initiatory stage, and further establisnments of motor-van service are heard of constantly, a recent one being the projected line between London and Tunbridge Wells, in direct competition with the railway. In the States the movement is not so far advanced—partly because of the poorer roads, partly because of the lower railway charges; but beyond question the heavy motor vehicle has a greater future than the automobile carriage. And it would not be surprising to find again that the railway—which at first sight seems to be bound to suffer from the new order—will eventually profit largely from it.

* * *

Another matter closely connected with the economical transportation of merchandise in which the United States are relatively backward in the parcels post, concerning which a vigorous agitation is now promised. At present the United States have no parcels-post arrangements except with Germany, and the result is that the American exporter—or would-be exporter—of goods in small quantities is effectively shut out of many foreign markets for simple lack of reasonable transportation facilities. An instance is cited of a manufacturer in the States who desired recently to fill a small order from the Argentine Republic requiring the transmittal of a three-pound package valued at $3.00. The only forwarding agency open to him was the private express companies, whose charges on this package would have been $6.30. It was not sent. And it is pointed out that an English exporter, filling the same order, could do so through parcels post at a total cost of $0.57.

* * *

John Wanamaker is credited with having said, when he was postmaster-general of the United States, that there were four strong reasons why the parcels post had not been adopted by the United States—and then he named the four great express companies of the country. The opposition of these private corporations is generally charged with having so far obstructed the introduction of a system which has been so profitably extended by England and Germany, to say nothing of the minor industrial competitors of the United States. But there is another strong factor of opposition, though how far it has been developed and pushed forward as a bogey by the express companies it would be hard to determine; that is, the fear lest an unequal advantage or, indeed, any advantage, be given the foreign exporter to the United States. It is the old protectionist idea over again in its narrowest form. And those Americans who would live in utter tariff-made seclusion, point to the records of the German-American parcels-post as confirmation of their hideous dreams, crying, "We told you so! They are sending us more than we send them! The advantage is in their favour! Away with it all!' And this in spite of the fact that the general trade balance as between Germany and the United States was largely in favour of the latter.

The simple explanation, of course, is that Germany, as the only European country having a parcels-post with the States, is used as a sort of general clearing house for Great Britain and the Continent in all business of this character, and the figures showing the nominal German business represent in addition the total of English, French, Austrian, Swiss and Belgian parcels-post business with the United States, which get no direct reciprocal advantages with these countries. The American exporter by mail orders has again, as in the case of the Russian business described by Mr. Ford in our July issue, to work by indirection and "underground road" through Germany, to the cumulative advantage of the German who appears as the direct agent in the business. Such conditions can not long be permitted by the American export manufacturer, thoroughly awakened to and vitally dependent on the valuable business to be had in the world's markets.

* * *

Reference was made in these columns some time since to the value of the Engineering Index as a barometer of industrial and technological thought. The waxing and waning of the bicycle—the rapid progress of the automobile—the striking rise of the gas engine—the growing importance of the steam turbine—all are closely gauged by the space occupied in the Index columns. But another attribute of the Index, clearly observable only by those who read for and compile it, is its effectiveness in displaying the reflected thought of THE ENGINEERING MAGAZINE as it comes back from our many exchanges. Thus to quote recent instances only, our leader of December last, on the Anglo-German agreement, was found copied, quoted, or commented upon, in more than eighty home and foreign journals and periodicals. The late Mr. T. C. Clarke's study of American bridge-building, Mr. E. Phillips' review of the British steel-making industry, Mr. Bogle's analysis of the influences affecting the Puget Sound region, and Mr. Ford's Russian papers had fully equal quotation, while nearly equal notice was given to Mr. Redfield's analysis of the prospects for Anglo-American industrial supremacy, Mr. Strong's review of mining opportunities in the Philippines, or Mr. Going's study of industrial communities, old and new. Mr. Diemer's series on Commercial Organization of the Machine Shop spread, in translation, through France, Germany, and Belgium; Prof. Pupin's article on long-distance telephony was done into Italian.

* * *

But someone has defined fame as seeing one's name mis-spelled in the newspapers, and possibly the analogy in journalism is seeing one's self misquoted in the exchanges. We were lately credited—or charged—with an item on the "Origin of Family Names," which seemed quite foreign to our province, and also with a stray paragraph on "Poisonous Plants"—which, by the way, was even unusually full of misinformation. Even a little foundling poem on the Sweetness of Killarney in the Spring was laid on our doorstep.

More curious are the slightly altered paragraphs from the Magazine which occasionally turn up, launched no one knows how, but suspiciously capable of serving some one's purpose under assumed cover of the Magazine's authority. We have previously referred to one, originally commenting upon a possible scarcity of gutta-percha, which was altered by changing "gutta-percha" to "rubber," and then sent out broadcast. Forty periodicals brought back to us our imputed statement that "rubber is scarce," when as a matter of fact every one knew that the possible sources of crude india-rubber are being continually added to at an enormous rate. And the latest changeling is headed: "Markets for Liquid Air. Engineering Magazine. Although liquid air has been in use for many years in the steamships and railways of the Black and Caspian Sea district, etc." Of course, what THE ENGINEERING MAGAZINE wrote was "Liquid Fuel" (Review of the British Press, Jan., 1901, page 779). It might be interesting to know how the changes in both title and body of the article were made, and why.

REVIEW OF THE BRITISH PRESS

The Coal Problem.

In a paper recently presented before the Society of Arts by Lieutenant Carlyon W. Bellairs, R. N., and published in the *Journal* of the society, the relations of the coal problem to the general welfare of the empire were very fully discussed, and some most interesting points brought out.

After recalling Jevon's statement that coal is "the mainspring of modern civilisation," Lieutenant Bellairs proceeded to show the futility of attempting to prophesy as to its future use or extent of application. In 1871 the royal commission reported that there was reason to doubt whether there would be much further increase in coal exports. That was 30 years ago, while in the past decade the exports of coal reached 358 million tons, there having been placed in the bunkers of steamers during the same period exactly 100 million tons. As a matter of fact the important proportion which coal exports bear in showing the total exports of Great Britain is not always realized, and in examining the extent to which Germany and America have entered British markets for other things a better idea will be obtained by deducting the amount due because of coal exports.

In considering the present commercial relations of British coal to that of other countries there are several points, all of which must be given proper consideration if intelligent conclusions are to be drawn. A most important feature is the cost of transport. The rates of freight on coal on the railways of the United States are about one-fourth of those in England, and in Germany they are about one-half. This and the greater ease with which the American coals are being mined, due to wider seams, less depth, and the extensive employment of coal cutting machinery, give the reasons for their lower prices.

It is a mistake, however, to speak of coal, as a general term, tacitly admitting that a ton of coal is the equivalent of every other ton of coal. On the contrary, the differences in the qualities of coals, causes correspondingly wide differences in prices, and materially complicating the problem. No real comparison can be made of the values of various coals without the fullest information as to the physical and chemical properties, as well as the evaporative qualities.

Considering coal as the mainspring of national welfare, its relations to the empire should include the interests of the empire as a whole. Now naval strength is the safeguard of the empire, and permanent naval strength is based on commercial prosperity, hence to impair commercial strength is to risk naval supremacy. Great Britain possesses a virtual monopoly near the sea of the finest steaming coal in the world. That this coal should primarily be used for the benefit of Britain is imperative, but the exports of quantities of it for the use of the navies of other nations is not without its advantages. Nations which, in times of peace, allow themselves to become entirely dependent upon British sources of coal supply, will find themselves terribly handicapped when at war with Great Britain.

Such considerations might make it appear feasible to restrict the export of certain Welsh coals, or for the acquirement by the State of favourable mines in the interests of the navy, but such a plan is altogether different from the imposition of an export duty on all coal for the protection of manufacturing industries. As Jevons said, coal is Britain's great outward ballast freight and "the inevitable progress of free trade will ever increase the tendency to export coal." In other words, the bulk of the export cargoes to balance the imports of wheat, timber, iron ore, and other raw materials, must consist of coal.

"We may dismiss from our minds all the talk about sudden exhaustion of our coal supplies. It must go through two stages, though inventions may retard the process. There is a stage at which we diminish our exports and begin to import. We are then nearing the exhaustion of the cheaper supplies. It is estimated that we have at least 20,000 million tons at such depths and of such widths as can make no sensible difference in prices. In addition fresh coal fields may be worked, for borings have been proved in other parts of England besides the well-known cases in Lancashire and Kent. Allowing for 20,000 million tons at an average production of 300 millions a year, the cheap supply would last seventy years. If we assume that one-fifth is wasted, or left in the ground as props, then the cheap supply will last fifty-six years."

The above considerations apply to British coal alone, but when we take the whole empire into account we have the almost untouched supplies of Canada and of India to deal with. With the coming of imperial federation it should be a matter of indifference in what part of the empire industries are developed. The growth of the iron and steel manufactures of Cape Breton is an example of what may be expected in other places. Developments of mining sections take place with great rapidity, as the growth of the coal production of the world in the closing quarter of the nineteenth century shows. The world's output of coal rose from 142 million tons in 1860, to 700 million tons in 1900; of which Great Britain's proportion was 84 million in 1860 and 224 million in 1900.

In summing up the existing position Lieutenant Bellairs concludes:

1. That the shipping trade of the United Kingdom is largely dependent on, and has increased with, the coal trade to the extent of nearly 140 per cent. in 30 years; and that it is undesirable for this and other reasons to restrict the coal export trade.

2. The requirements of the navy can be met by the State purchasing adequate mines. These requirements for a century's supply do not amount to more than four years' output of the Welsh mines.

3. There is a real need for interference in the coal mining industry in the interests of economy, for the provision of reserve coal, and for the prevention of strikes. The compulsory working of mining grounds, the amalgamation of companies, the extinction of royalties, and transport facilities are separate questions requiring investigation.

4. The provision of the fullest possible information concerning coal resources is of the utmost importance.

"No country or empire in the world can show such an increase in the volume of its commerce during the last thirty years as the British Empire. On the other hand, it is unreasonable to hope that the United Kingdom alone can maintain the position it occupied in the seventies as regards the United States and Germany. Then much of the United States was virgin soil, and the German Empire was a young giant destined to rapidly grow. In the quarter of a century following, the population of the United States increased 30 millions, Germany 11 millions and the United Kingdom 8 millions. Our sole hope of predominance lies in our empire. We have to bridge over a period in which imperial federation is being accomplished, and the burden of maintaining our armaments will have to be borne during that period almost exclusively by the wealth and trade of the United Kingdom. Under such circumstances a nation may well spend its capital, even though that capital is coal, the source of its material welfare. That coal is lying unproductive in the earth. In this most critical period of our history, when we are reaching forward in imperial federation to an even greater predominance than we possessed in the seventies, it is essential that we should enhance our production and profitable exports of coal by all means in our power. By acting thus we are able to raise greater wealth for the building of battleships, which enable us to achieve our destiny in peace."

It is a bold idea, but strong because of its very boldness. Instead of husbanding the nation's resources, the capital of the land, in the form of its yet existing stock of coal, should be thrown on the market with all speed, and the proceeds invested in naval equipment to enable Great Britain and her colonies to become the greatest federated empire the world has yet seen. This accomplished the parent island can safely look to other parts of the empire to maintain the coal and manufacturing supremacy she once possessed; serenely reposing upon the laurels of her past, and secure in the strength of the empire of which she forms but a part.

The Liverpool Motor-Vehicle Trials.

In the development of motor vehicles different countries appear to have taken up different portions of the problem, not by any sort of agreement, but rather from the influence of local conditions. In France the pleasure and touring vehicles have reached a high degree of elaborateness, and in the recent race from Paris to Berlin we see the natural result of what must be considered a one-sided development. Another development, also one-sided, perhaps, and on the opposite side from that seen in France, is found in the trials of the Liverpool Self-Propelled Traffic Association. Here it is the motor truck and lurry, for carrying heavy merchandise in competition with horse-drawn vehicles, which has received attention, and as a result of these trials it is not too much to say that England has surpassed all other countries in the development of motor vehicles for heavy traffic.

It is now two years since trials of motor cars have been held by the association, and hence those recently concluded have attracted much attention. This was more especially the case since it was intended that demonstrations would be made which should influence the Local Government Board to consider favourably the proposal to modify the present regulations, under which the maximum tare weight of vehicles must not exceed three tons. At the previous trial all the competing vehicles have been kept within this limit, and the result has been beneficial to the extent of causing great care to be exercised in the use of material and the distribution of weights.

This year, however, in addition to the smaller cars, arrangements were made for the trial of two new classes of car on which no tare limit was fixed, the object being to show the feasibility of extending the limit to a desirable point beyond that of the present rules.

A full report of the trials and description of the vehicles taking part therein is given in the *Automotor Journal,* from which some abstracts are made.

Among the especial requirements in the general regulations we note the following: In addition to the ordinary demands upon motor vehicles, the cars entered for trial shall have sufficient water capacity for a run of 15 miles, shall be capable of starting from rest on a gradient of 1 in 9, and shall be capable of working in and out of an embayment of one-and-a-half times their own lengths. No restriction is made as to the character of motive power, or the nature of the agents used, but with the exception of class C, in which no tare limit is imposed, all vehicles must comply with the Locomotives on Highways Act, 1896. Limiting dimensions and weights are also given for the various classes, as well as the speeds, which are 8 miles per hour for class A, of 1½ tons load and 2 tons maximum tare, and 5 miles per hour for the heavier vehicles.

Space does not permit of a detailed description of the various vehicles which entered in the trials, and the reader must be referred for details to the original report. A few general remarks however, will give some idea of the character of the various cars. In the trials of 1899, all the vehicles entered were propelled by steam power, and it then appeared that this was the only feasible kind for such service. In the present trials, however, there were two petroleum motors, both of which worked well, although being of the same design, they gave no opportunity for comparison.

In the case of the steam cars, the general design was the same in all, the boiler being forward and the water-tank behind. The details varied greatly, vertical water-tube, vertical fire-tube, locomotive, and flash boilers all being in use. The steam engines were generally of the two-cylinder compound type, with provision for the use of high-pressure steam in both cylinders for starting or overcoming heavy resistance. Single-acting high-pressure engines were also employed in connection with flash boilers. All vehicles were fitted with change gears, giving two changes, these being engaged either by sliding the teeth in and out of mesh, or by the use clutches; it being necessary to shut off steam while changing gear.

Freedom of action between the sprung and unsprung portions of the gear is obtained either by chain connection or by universal joints; the differential gear in all cases being arranged so as to be readily locked. With but one exception the Ackermann steering method was employed, this machine having also no differential gear, but using a separate engine for driving each rear wheel. An independent reserve method of feeding the boiler appeared in each case, and condensers were not found on any of the competing vehicles.

"Throughout these steam wagons, one cannot but be struck by the enormous improvements which have been made both in their construction and in their capabilities; the majority of them bear ample evidence to the fact that heavy road vehicles have now been brought to a stage at which they are entirely suited for continuous and reliable duty under any of the usual working conditions, and at which minor improvements only may be expected in the future. In the matter of serious vibration, even when travelling over the worst roads, all the cars were remarkably free from this; even fragile goods could evidently be carried with out fear of breakage, if they were packed with reasonable care."

The report, although only that of the publication referred to, and to be supplemented by the official report of the judges, shows that the requirements were by no means too difficult of accomplishment, the details of the various trials showing the success with which they were met. Awards were made to all the vehicles in all classes except class D, which was held under advisement.

The Properties of Steel Castings.

Among the papers recently read before the Iron and Steel Institute was one by Professor J. O. Arnold, upon the results of experiment on the properties of steel castings, these experiments having been commenced about six years ago. These experiments were undertaken to determine a number of important points, such as the influence of chemical composition, of annealing, of variations in specific gravity, of heat treatment, etc.

It is impossible in this place to give a full abstract of this important series of researches, but some general idea can be given of their scope and the nature of the results, referring the interested reader to the original paper for full details.

The specimens were made to conform as nearly as possible to the specifications at present issued by engineers for high-class material, and as far as chemical composition was concerned they were grouped according to character as: nearly pure iron and carbon castings; iron, carbon, and silicon castings; and iron, carbon, and manganese castings. These were cast in test pieces in such a form that four test bars were obtained from each feeder, two being tested as cast, and two being annealed, in each case.

The effects of annealing are very clearly shown in the numerous reproductions of etched sections, the methods of metallography being most successfully applied to make the physical constitution of the specimens visible. The method of annealing was very thorough when it is remembered that the test specimens were only 0.25 square inch area and 2 inches long. The pieces were annealed in covered cast-iron boxes, filled with lime and maintained at a temperature of 950 C. for about 70 hours. This was followed by about 100 hours of cooling, after which the pieces were drawn. While this drastic treatment was hardly necessary for such small pieces it must be considered that in practice the juxtaposition of light and heavy masses requires prolonged soaking, not for hours but for days, in order to bring all parts to a common temperature.

The most important result of the tests was the demonstration of the unsuitability of pure iron and carbon steel as a material for the fulfillment of the modern specifications by engineers for steel castings. Ductility can be secured with ease, but without the required tenacity; while if tenacity is obtained it is at the expense of ductility. Thus far the results of the tests have been of a negative interest, but this may prove of a decidedly positive value as showing the necessity of employing some other composition.

The trials upon the influence of silicon and of manganese, which are yet to be made, will doubtless prove of more positive interest, and the whole series, when completed will add much to our store of knowledge of this most important branch of the materials of construction.

Merchant Vessels as Naval Auxiliaries.

In view of the recent employment of vessels of the American line as naval auxiliaries during the Spanish-American war, the paper of Lord Brassey before the Institution of Naval Architects is important and interesting.

The history of the question was briefly traced in the paper, the earliest contracts for the conveyance of the mails providing that postal vessels should be suitable for conversion into armed cruisers. Sir Nathaniel Barnaby urged the subject in 1877, and his views met with hearty support, while Admiral Fournier emphatically stated that the great transatlantic liners were destined to be the commerce destroyers of the future.

Passing on to the later authorities the practicability of so constructing merchant steamers as to render them readily available for war purposes was discussed by Mr. Biles in a paper read at an engineering conference, held under the auspices of the Institution of Civil Engineers in June, 1899. Arguing from the results of arming and fighting the mercantile cruisers of the United States Navy, Mr. Biles takes the view that such vessels are not unable to cope with thoroughbred warships. The experiences of modern sea fights point to the conclusion that a ship is more liable to be disabled by her crew being driven from their guns than to be sunk by the effects of shell-fire. The issue of a fight between a warship and a merchant ship may not turn on the relative efficiency of the internal subdivision, but on the protection of the guns. By placing the guns in a box battery, as the Americans did, a considerable number of guns could be as well protected in merchant ships as in first-class cruisers. Mr. Biles holds it to be practicable, with due consideration in the early stages of design and construction, to so protect machinery and armament that the merchant ship need not be much, if at all, inferior to many warships.

"The policy of liberal subsidies to the Mercantile Marine has given to the merchant navies of foreign Powers a decided advantage in the possession of the types of vessels most suitable for naval purposes. The Germans have taken the lead. They have two ships now running—the Deutschland and the Kaiser Wilhelm, of 14,000 tons and 15,000 tons respectively—which exceed in speed by nearly two knots our best ships. No vessel now building for the British flag will rival in speed the Kaiser Wilhelm II. and Kronprinz Wilhelm under construction in Germany."

Lord Brassey calls attention to the fact that notwithstanding Great Britain equals the combined merchant navies of the world in actual tonnage fewer than one-half of the 157 ships of 16 knots and over are under the British flag. Out of the £2,000,000 which Parliament has been asked to vote for the navy only £63,000 is payable to the owners of reserve merchant cruisers, in spite of the disproportion above shown. It is the fixed resolve of the people, and, perhaps the first duty of British statesmen, to keep the Empire secure from attack, and to give protection to the commerce on which our existence depends. In pursuance of this policy we have more than doubled the expenditure under Navy Estimates, and still we seem to fall short of the full requirements for the naval defence of the Empire. It would be impossible to fix a limit to the number of cruisers required for the protection of a commerce which extends over every sea. The construction of cruisers has absorbed in recent years a large proportion of the shipbuilding votes. But when the cost of the first-class types falls little short of that of the battleship, the numbers we can build are all too few for the work they might be required to do. We cannot cut down the expenditure on battleships.

"If, therefore, our regular-built cruisers are fewer than we could wish, we must look to our Mercantile Marine, and, out of the abundant materials we there find ready to our hands, we may organise a supplemental fleet of armed cruisers such as no other State can furnish. The Admiralty should utilise these resources by liberal subsidies. The standard of requirements should be high. The speed should not be less than that of the Deutschland—let us say, 22 knots at sea. Mercantile auxiliaries should be protected by a deck or belt of Harveyised armour—the necessary armaments should be in readiness. Calculations of cost can hardly be attempted in a paper in which nothing more is attempted beyond suggesting a policy."

It can however be shown that for a first-class cruiser, in addition to the cost of maintenance, the interest, depreciation, and insurance will reach £70,000 a year, while a mercantile cruiser can be retained at a cost of only about £10,000 a year.

"We must further take into view the economy resulting from the maintenance of the mercantile auxiliary by the ship-owners, as against the maintenance of the man-of-war in our Royal yards. In conclusion, I claim that it has been clearly shown that we can have many auxiliaries for the cost of one cruiser; and these auxiliaries may have effective protection. If not equal to the ship of war as combatants, they will be superior in coal endurance and probably in speed for long distances. They would be the scouts of our fighting squadrons. They would protect our commerce from interruption by the auxiliary vessels of a hostile Power."

Coal Cutting by Machinery.

At the conclusion of a series of articles on coal-cutting by machinery, which has been running for some time in the *Colliery Guardian,* some points bearing emphatically upon the colliery practice of Great Britain are made which will bear noticing here.

In the first place the whole of the coal in the United Kingdom must be cut by machinery if foreign competition is to be met. The parallel is drawn between coal production and corn production, and the manner in which American agricultural machinery caused English wheat to be a thing of the past is cited as a warning.

Usually much difficulty is met in attempting to introduce improved machinery into collieries. It is thought out of all reason to alter any of the arrangements of the colliery to give a new invention a chance, no matter what the ultimate advantages might be. If the English coal industry is not to go the way of the English wheat industry this attitude must be changed.

"The inventor must have reasonable facilities, and collieries must either go to the inventor, or work out the problems themselves. The latter would be the very best solution of the problem, if each colliery manager set himself seriously to do all his work by machinery, to introduce machinery everywhere, remembering that every machine does two things, if it is a proper machine, viz., it renders the manager independent of men to the extent of the number of men the machine displaces, and it is something done to enable the industry to compete with the coming American invasion. For the American invasion will come, as it has in other industries."

A natural result of the treatment which engineers meet in endeavoring to introduce improvements into the colliery is seen in the reluctance of manufacturing electrical firms to undertake colliery work, especially as they are able to obtain plenty of work in directions in which they are welcomed. The suicidal result of this policy is evident.

"The American invasion may be taken as a foregone conclusion. The course which has been adopted in the case of every other industry is being adopted in the case of coal. First, the English product is bought largely, then the machinery by which the English product is made is bought largely and the men who have been engaged in making it, then the English product is barred out by a tariff, which is gradually increased while the home trade is built up; then as the output is increased it gradually overtakes the demand, and the surplus is promptly shipped off to Europe, or wherever else it can be got rid of and sold for whatever it will fetch. By this last a foreign trade is built up, and by then the introduction of machinery has brought down the cost of production and transport to below that of all but specially favoured cases."

The Economical Speed of Ships.

Among the papers presented before the recent meeting of the Institution of Naval Engineers that of Mr. E. Tennyson d'Eyncourt upon the limits of economical speed of ships present features of much value.

It has, perhaps, been too common a practice in fixing the speed for a vessel, and in estimating the necessary indicated horse-power for that speed, to overlook the question of what speed is appropriate to the form of vessel under consideration, and to go upon the broad basis of allowing plenty of margin of horse-power, with the result that often too high a speed has been aimed at, and too much power has been allowed. As a necessary consequence, the weight and cost of the excess has been a continual burden upon the earning capacity of the ship. This was, perhaps, very well when competition was not so keen, but nowadays, when cost has to be cut down to a minimum in every direction, not only by the shipbuilder, but also by the ship-owner, the question of giving a ship enough, and not too much, power and speed has become one of first importance.

It is necessary to bear in mind the fact that every ship has an appropriate limit of speed, beyond which it is most uneconomical to attempt to drive her; or, in other words, any increase of speed beyond this limit requires an undue increase of power. It has therefore been the object to arrive at a method of defining this limiting speed for ships of different sizes and different forms.

A general solution of the problem is almost an impossibility, but by a careful analysis of the performances of different vessels some fairly comparative results may be obtained. Computing the resistance due to skin friction, according to Froude's method, and deducting this from the effective horse power at any speed gives the power necessary to overcome the so-called residuary resistance, which at the higher speeds is principally caused by wave making.

The ratio of wave horse-power to skin horse-power at the limiting speed depends, of course, upon the form of entrance and run and the mean girth of the vessel up to the water line; but ½ seems to be a fair average value for vessels of fine entrance and run and full midship section. If the midship section is fined, and the wetted surface thereby reduced for the same block co-efficient, it naturally follows that the entrance, or run, or both, must be filled out, with the effect that the skin resistance is reduced, and the wave-making increased, bringing the curves of skin horse-power and wave horse-power more closely together, as indicated by the dotted curves on the diagram, and bringing the point where skin horse-power is equal to wave horse-power to a lower speed.

It is therefore impossible to lay down general rules to meet all cases, as the variations which may occur are almost infinite in number, and so only an indication of the kind of thing that may be expected can be given. Considerations of stability, involving beam, or fulness of water line, or of girth, which affects weight of hull, more especially if the vessel is to be built to Lloyd's rules, or the question of docking facilities, are merely examples of what the designer has to take account of, and they often hamper him in adopting what he knows would be a better form, or more suitable dimensions for the speed than those he is compelled to take.

The skin horse-power varies as the 2.83 power of the speed, but the wave horse-power varies as the 7th power at the limiting speed and as high as the 10th power at 12 per cent. above the limiting speed.

Plotting the various results as curves corresponding values for C the constant in the admiralty formula:

$$C = \frac{D^{\frac{2}{3}}\, v}{\text{I.H.P.}}$$

are deduced as follows:

Length of Ship on Water Line. Ft.	Value of C at Limiting Speed.	Value of C when Skin H.-P.=Wave H.-P.
200	225	188
300	250	207
400	278	224
500	205	237
600	310	246

These values of C are less for the smaller ships, on account of the higher coefficient of friction for the shorter length of vessel, and also on account of the error in the assumption of the general truth of the law of comparison when applied to the whole resistance. These two causes are not, however, sufficient of themselves to account for the decrease in the value of C. I think this decrease is partly due to eddy-making, caused by minor projections and irregularities in the surface of the smaller ships, these irregularities being on a proportionately larger scale in the smaller than in the larger vessel. It must also be borne in mind that any roughness of sea or wind has a greater effect in proportion on the smaller ships, tending to spoil their performances on trial, as compared with those of larger ships.

It has been found that the indicated horsepower is usually increasing as the 7th power of the speed when the skin horse-power, is equal to the wave horse-power, or at about 12 per cent. above the limiting speed.

"This is then the speed at which it becomes economical to increase all the dimensions of the ship in the same proportion; of course, from the point of view of driving the greatest displacement at the given speed.

"There are many vessels in which this limiting speed is far exceeded, such as fast cross-channel passenger vessels, torpedo gunboats and destroyers; but these types are for very special requirements, and are not economical in the sense of carrying large displacement at the required speed. They are not, therefore, included in the scope of this paper. Nor do the figures given apply to vessels of very great beam in proportion to their length. The examples taken are all of ordinary proportions, not less than 6½ beams in length, and of ordinary draughts; but, as this includes practically all mercantile vessels, and also cruisers of the usual dimensions, the range is fairly wide.

Naval Boilers.

President Lincoln is credited with the homely saying, when urged to make an important change in time of emergency, that "It is a bad plan to swap horses when crossing a stream." The same maxim might be applied to the action of the admiralty in the matter of the naval boilers.

An editorial in a recent issue of the *Engineer* contains some timely words in this matter, calling attention to the imminent fact that the whole shipbuilding programme remains chaotic and disorganized because no one knows what boilers are to be put into the warships. The cylindrical boiler has been abandoned and water-tube boilers have been determined upon. The Belleville boiler has been condemned by the interim report of the Admiralty Commission and no other boiler has been definitely adopted. In the meantime competitive trials are made between the Hyacinth and the Minerva, both of which vessels are equipped with the identical types of boilers which have been condemned as unfit for naval use. What earthly use such trials can be remains to be discovered.

There seems to be a serious impression existing that nothing but a large-tube boiler will do for naval service, notwithstanding the fact that the only boilers which have been continuously satisfactory are of the small-tube express type. All the large-tube boilers have given difficulty with the bending of the tubes, and this appears to have little or nothing to do with the detailed construction, and is apparently inherent in the type. Further experience is called for to discover the cause of this and other difficulties, but in the meantime there is nothing whatever to prevent the equipment of one or more vessels with small-tube boilers of the Yarrow and Thornycroft type. There is nothing now experimental about these boilers, and they have been successful under the most trying conditions. To put such boilers at once into the vessels now in uncertainty could do no harm, and would indeed effect much good. Such action could make no delay in the investigations which are under way concerning the boilers which it has been decided to abandon, nor would it prevent the discovery of the defects in those which it is suggested to adopt. In the meantime work on important warships would not be needlessly delayed, and confidence, now sadly strained, would be restored. The whole story is summed up in these few words: "The express boiler is, on the whole, able to comply with all the requirements of a ship of war. No other type of water-tube boiler has established a reputation for itself anything like this, while several are absolute failures, or unsuitable for naval purposes."

If it is desired to adopt the combination of cylindrical and water-tube boilers, the small-tube boiler appears eminently adapted to act as a prompt reserve for the tank boiler, and this arrangement might be worth trying. In any case, however, let the present uncertainty be terminated, and let the vessels now under construction be equipped with boilers about which everything is known, and let the long-drawn-out experimenting with uncertain types be continued with something less important than the navy upon which the fighting strength of the empire depends.

REVIEW OF THE CONTINENTAL PRESS

The Power of the Upper Rhone.

The extent to which Switzerland has utilized the water power of her glacier-fed streams has caused longing eyes to be directed towards these valuable natural resources from other directions. France, especially, sees in the Alps of Savoy a valuable source of motive power, and the use which Switzerland has already made of the Rhone has caused important plans to be made regarding the utilization of the power of the same river after it has entered French territory.

In a paper recently presented before the Société des Ingenieurs Civils de France, and published in the *Mémoires* of that society, M. A. Garcia gives an exhaustive study of the utilization of the falls of the Rhone from the Swiss frontier as far as Pyrmont, a distance of about 27 kilometres (less than 17 miles).

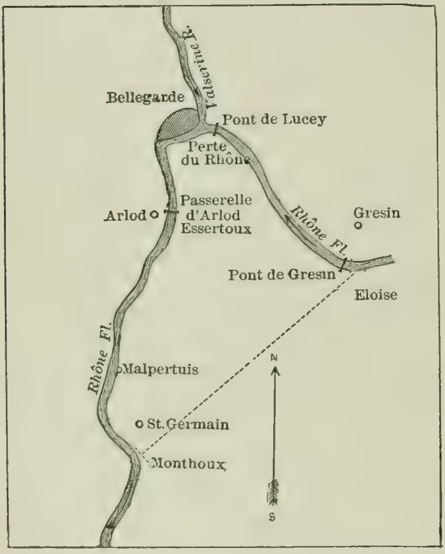
This portion of the Rhone is not navigable, even for small boats, but traverses a rough country between rocky banks occasionally more than 100 metres in height, while at one point, about 600 metres above Bellegarde, the stream is precipitated from a height of 13 metres into an underground bed where it is lost to view for a space of 200 metres. There is, therefore, no useful purpose to which this part of the river can be applied other than the production of motive power, and it is to the best utilization of this power that M. Garcia devotes his discussion.

Instead of permitting the water power to be improved by disconnected plants, under private enterprises, he advocates the preparation of a complete scheme for the best development of the natural power available, believing the importance of the subject such as to render it worthy of government supervision and concession. The mean total power available in the portion of the Rhone from the Swiss frontier to Pyrmont is estimated at more than 160,000 horse power. The flow of the river is very variable, ranging, according to the long-continued observations of the official service at Geneva, from 57 cubic metres per second for very exceptional low water, to 1,230 cubic metres at the extreme, and equally exceptional floods. The ordinary variations range from a low water flow of 170 cubic metres to a flood delivery of 900 metres, there being a fairly constant flow of 200 cubic metres per second for a period of about 325 days in the year. The very low water occurs in winter, while the floods, due to the melting of the snows, are in June, July, and August.

The power company at Bellegarde already has the concession for 60 cubic metres per second, and is desirous of obtaining the right for the entire flow of the river, while at the same time three other projects are under consideration for the establishment of power stations at other points on the stream. The fall at Bellegarde being 13 metres, a flow of 60 cubic metres should give a gross power of 10,400 h. p., while in fact the plant now in operation utilizes but 4,000 h. p. The proposed plants would be situated at Pont de Grésin, about 11 kilometres from the Swiss frontier, where a dam would permit a maximum of 34,000 h. p. to be obtained; at the Boucle du Rhone, where a tunnel of 1,370 metres long across the bend of the river above and below Bellegarde would enable the utilization of more than 50,000 h. p.; and, finally, by the proposed plant at Malperthuis, where a similar tunnel across a loop in the stream would permit about 32,000 h. p. to be developed.

The details of the cost of installing these various plants are examined by M. Garcia, with the result of an estimated cost of 260 francs invested capital per horse power, while if the plans for the Pont de Grésin and the Boucle du Rhone are united, by the construction of a combined canal and tunnel this cost would be reduced to 183 francs per horse power, for installation charges.

M. Garcia, however, advocates an entirely new scheme, to replace those already under consideration. Having made a careful study of the cost and advantages of the successive utilization of portions of the stream, he proposes a channel extending directly from a point above the Pont de Grésin to Monthoux, this cutting across the long bend in the river upon which all four of the plans already referred to would be situated, and giving one fall of 57.50 metres for 200 cubic metres of water per second, corresponding to 153,300 h. p. Between Monthoux and Pyrmont there is sufficient if all to make it practicable, by the construction of a dam, to utilize 16,000 more h. p., giving a total of 169,300 h. p.



The general arrangement of the proposed plans will best be understood by an examination of the map upon which only the points directly involved in the proposed schemes are indicated.

The chief objection to the plan of M. Garcia, besides that of the rights of the existing company, is the length of the canal required for the delivery of the water across the bend of the river. The total distance is 10,700 metres (6.64 miles) of which 4,600 metres would be tunnel (2.86 miles). The cost of this plan, entire, is estimated at 24,300,000 francs, or for 153,000 h. p., 158 francs per horse power.

In urging the adoption of a single complete plan for the development of the hydraulic power of the upper Rhone in France, M. Garcia makes some interesting observations upon the growing importance of water power in connection with electric transmission.

When we consider establishments operating continuously with large power, the steam engine cannot possibly compete with water power. The development of large hydro-electric stations must work a complete revolution in such industries as demand much power, such as electro-chemical and electro-metallurgical establishments, given ample power at moderate cost, and it it difficult to predict the limits of electrochemistry. The possibility of fixing the nitrogen of the air by electrical action would make it practicable to replace the enormous quantities of nitrate of soda and sulphate of ammonia now used as fertilizers, and water alone would be necessary for the requirements of agriculture. Electric traction, deriving its source of power from the hydraulic energy of mountain streams, has already been developed in mountainous countries, and in Italy and Switzerland may be seen the results of this influence.

The most important effect, however, is to be looked for in the transmission of electric energy to the vicinity of the power stations, building up industrial centres otherwise impracticable. In this connection it is interesting to note that the advantages of electric power in local distribution appear in a marked degree when steam is replaced by electricity. A manufacturer, using 50 h. p. from a steam plant, for instance, in replacing it with electric power arranges for an equal amount, but finds in practice, that he uses but 35 h. p. to accomplish the same work, the difference representing the amount formerly lost in transmission and distribution by the wasteful employment of shafting, belting and hope transmission.

Certain it is, that in these days of rising coal prices, and closer manufacturing economies the owner of mountain streams, derived from the never-ending supplies of white coal, can no longer be neglected by those countries so fortunate as to possess such stores, and the location of the industrial centres of the coming generation may be greatly affected by considerations hitherto almost neglected.

Progress in Aluminothermy.

We have already noticed in these columns the process of Dr. Hans Goldschmidt for producing very high temperatures by the combustion of aluminum alloys. At the recent meeting of the *Verein Deutscher Eisenhuttenleute* Dr. Goldschmidt delivered an interesting address, accompanied by experimental demonstrations, showing the recent extensive developments of the process and from the report of the address in *Stahl und Eisen* we make some abstracts.

Prominent among the applications of thermite, as the Goldschmidt alloy is called, may be noted the reduction of such metals as chromium and manganese without the presence of carbon. This reduction is effected in large crucibles, holding several centners of metal, and the operation is rapid, requiring scarcely more than half-an-hour for a charge. The resulting chromium, being entirely free from carbon, is especially valuable in the manufacture of chrome steel, while the manganese produced in a similar manner is used for making manganese bronze. Chromium prepared in the ordinary manner contains 10 to 12 per cent. of carbon, and its addition to steel materially modifies the carbon content.

This pure chrome is also useful in preparing other alloys, while pure titanium may be made and used in a similar manner.

Various useful alloys may be made with pure manganese, the absence of iron and carbon being especially important, and there is every reason to believe that the commercial production of these metals in a pure state by the Goldschmidt process will open up some valuable alloys hitherto not obtainable.

Both nickel and cobalt may be reduced by combustion of aluminum, and while the cost of cobalt renders it unavailable the production of pure nickel is most desirable. In like manner we may reduce boron, vanadium, etc., and an entire new field of metallizing is opened by this possibility of working with a metallic fuel producing a remarkably high temperature.

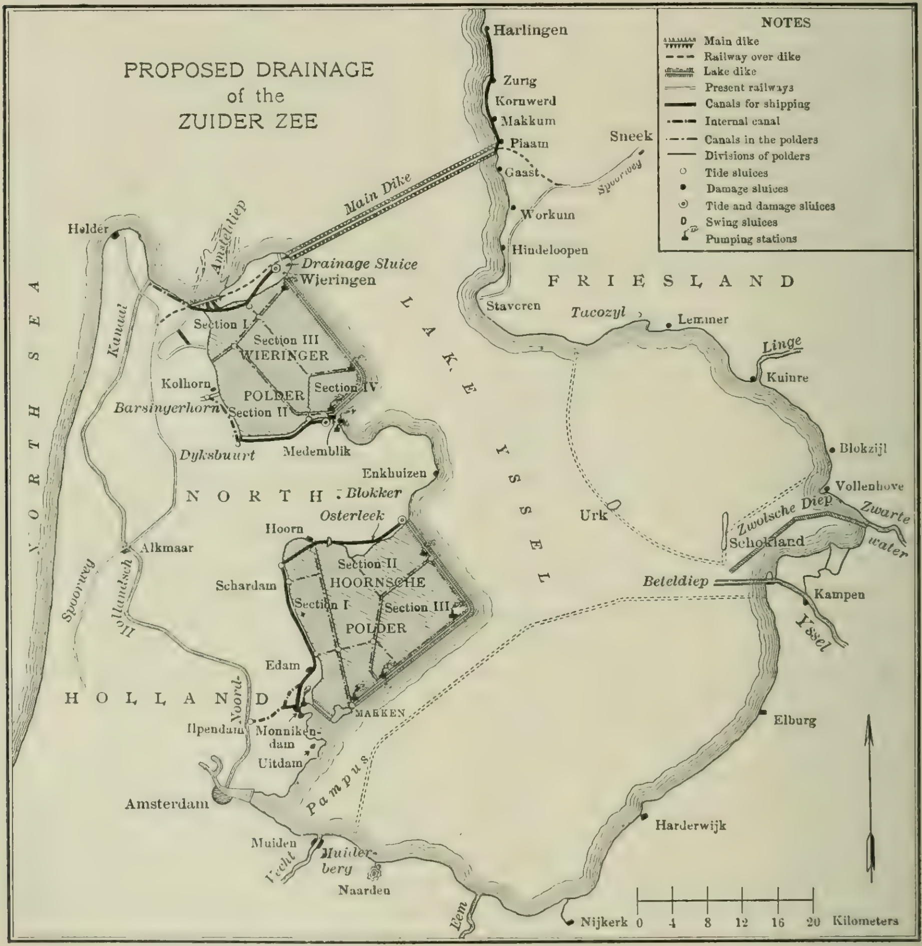
The practical uses of thermite as a means of melting or welding have become more and more extensive. By the use of special clamps and devices a number of operations, otherwise difficult, are readily performed, and as a means of repairing broken or defective parts, the use of thermite bids fair to become generally employed. By the use of a convenient and portable jacket and clamp, it is possible to weld the joints of pipes for gas, water, or steam, after the pipes have been placed in position, the joints in such cases being as strong under test as the other portions of the pipe. The advantages which the possession of such a material gives the engineer, far removed from supplies and repair shops, as at sea, can hardly be enumerated.

The employment of thermite for welding the ends of rails, has already been discussed. The value of continuous rails for the prevention of stray currents and consequent electrolysis of water and gas pipes is again emphasized by Dr. Goldschmidt. Not only for electric tramways, but also for the rails of main line railways. In the case of tramways the rails are imbedded in the earth to an extent which prevents great and sudden changes in temperature, and hence it has been found practicable to weld long lengths of rail, with but few breakages from expansion or contraction. On main lines, however, the rails are exposed to atmospheric changes of temperature, but in spite of this it has been found practicable to join several lengths of rail by welding and thus materially reduce the number of open joints. In tunnels, where the temperature is practically constant and where the elimination of joints is an especial advantage, the length which may be continuously welded is much greater.

Dr. Goldschmidt describes a number of instances in which the use of thermite for repairing broken pieces has been successful and advantageous. New journals have been welded to heavy rolls, broken pump-rods have been joined, and a number of structural combinations successfully united by means of this convenient application of intense local heating.

It is not to be expected that such an expensive combustible can be used in ordinary cases, but for special work, and for use in emergencies thermite offers many possibilities.

It is interesting to note that, as aluminum is now practically all produced electrolytically, the heat derived from its combustion may have its origin traced to the source of energy from which the electric current was produced, either water or steam power, and hence aluminothermy, as it has been termed, is practically an application, after several transformations, either of the heat of the sun, by which the water of Niagara, for example, was raised, or of the fuel burned under the boilers of some generating station.



The Reclamation of the Zuider Zee.

For a long time the idea of draining the body of water known as the Zuider Zee has been discussed in Holland, the plans of Van Diggelen having been proposed in 1849. These plans included the enclosure and reclamation of the whole of the area of the Zuider Zee within the north Sea Islands, but the magnitude and cost of the project proved too great an obstacle to its serious consideration.

In a recent number of *De Ingenieur* is given a description of the present project, which while less ambitious than the original one of Van Diggelen, seems far more probable of successful execution.

These plans are based upon those of Beijerinck, who, in 1866, proposed to cut off the Zuider Zee from the North Sea by a dike, and to drain a portion of the land, and these plans, further developed by Stieltjes, were taken up by the Zuiderzee-vereeniging, which body, since 1886, has been actively engaged in making surveys, and overcoming political opposition.

Briefly, the scheme now practically adopted consists in the construction of a dike across the mouth of the Zuider Zee from Wieringen to a point on the coast of Friesland, near Piaam. This encloses the inland waters of the Zuider Zee from the North Sea and at once reduces the length of coast line requiring protection from 320 to 40 kilometres, so that an immediate economy in coast protection is at once secured. A railway line will also be run across the top of the dike, thus shortening the communication between North Holland and Friesland.

The portion of the Zuider Zee enclosed by this dike will then be partially reclaimed, and partly converted into a fresh water lake. In order to avoid the delay in utilizing the reclaimed land the work is to be divided into sections, these being enclosed and drained successively, instead of attempting to do the work all at once.

The first portions to be reclaimed are the Wieringer polder, a section enclosed by a dike extending from Medemblik to Wierigen, and the Hoornsche polder, a similar area south of peninsula of North Holland. For later drainage there are reserved two much larger areas shown by the dotted lines on the map, these not being at present included in the immediate scheme.

The undrained space will form a lake, which being supplied by the river Yssel, will be known as Lake Yssel, and this will furnish a much needed fresh water supply to Friesland, and also avoid closing the water communication between Amsterdam and a number of towns now upon the Zuider Zee.

Apart from the engineering difficulties the questions of finance have been important, as it has been difficult to show a profit to independent undertakers for the scheme. The present plan, however, provides government backing for the company, this being warranted by the great gain to the State by the addition of such an area of new territory.

The estimates of cost include a total for the construction and protection of the great dike of 57,100,000 gulden, of which 4,500,000 gulden is for the compensation of the fisheries, and 8,000,000 gulden for defensive works. The cost of drainage is estimated at 12,700,000 gulden for the Wieringer polder and 22,850,000 gulden for the Hoorn polder, to which must be added 2,000,000 more for defense, or a grand total of 94,650,000 gulden, (about £7,800,000 or $38,000,000). The return for this expenditure will be the reclamation of 53,220 hectares of land, of which it is estimated that 46,250 hectares (about 115,000 acres) will be fully available for cultivation.

The necessary funds for the work are to be obtained from a loan running for 60 years, while the reclamation works are expected to be completed in eighteen years. The cost of draining the two larger polders is estimated at 85,000,000 gulden for the south-east polder and 50,500,000 gulden for the northeast polder; the respective areas being rather more than 100,000 hectares and 50,000 hectares, (247,000 acres, and 123,000 acres). These latter works, however, are not under immediate consideration, but naturally have been considered as an ultimate portion of the whole project which will begin with the construction of the main dike across the entrance of the Zuider Zee.

While the expense of this great work runs well up into the millions it may be regarded as money well spent, since it adds to a land, much of which has already been won from the sea, a large additional tract for a permanent possession. When we consider what enormous sums have been expended by nations without a murmur for the purpose of wresting territory from others by force of arms, we may well applaud a project which wages war for land with the ocean alone. In this respect Holland well deserves the consideration of statesmen who have yet to learn that among the weapons which are mightier than the sword may be included the spade of the engineer and the hammer of the mechanic.

Coal Handling at Rotterdam.

The port of Rotterdam is the natural outlet of the Rhenish-Westphalian coal district, not only because it is the nearest harbour, but also because of the excellent water communication afforded by the Aermel canal. The constantly increasing coal trade of the port, therefore, has made increasing demands upon the capacity of the coal-handling facilities, especially in connection with the coaling of steamers and the loading of colliers. In 1887 a 10 ton Armstrong hydraulic coal tipple was installed, followed by a similar one of 15 tons capacity and greater speed, by the same makers.

These two machines served the purpose of the harbour up to 1898, when the demands became too great for them. Already in 1893 the shipments of coal reached 114,000 tons for the year, while in 1896 the capacity reached 214,000 tons, and the machines were being operated to their extreme limit. In providing for the increased demand it was decided to adopt electric driving, and in recent issues of the *Zeitschrift des Vereines deutscher Ingenieure* is given a fully illustrated account of the new electric coal handling plant, now in active operation.

The new electric tipple was required to be of the same capacity as the second Armstrong machine, but the framework was made much stiffer and stronger. The operating machinery is enclosed entirely in the adjoining buildings, and each function is actuated by an independent electric motor. By thus placing the electric machinery in an enclosed space much greater care can be given to its protection, both from dust and from the moisture of the climate of Rotterdam.

The general construction of the machine is that of a pyramidal tower of structural shapes, forming guides and supports for a lift platform in which the wagon containing the coal is raised and tipped so that the entire contents are delivered into a chute leading to the hold of the vessel beside. This tower is about 75 feet in height, strongly braced, the top containing supports for the cable sheaves which serve to raise and tip the platform, the wire cables running from thence to the electrically driven windlasses below. In addition to the platform, there is mounted upon the upper part of the tower a derrick crane carrying a coal bucket, this being used to deliver the first portion of coal to the hold of an empty vessel, in order to provide protection against the force of the coal dropping from the main chute.

The work of the machine requires six independent windlasses, as follows: (1) hoisting and lowering the car platform; (2) tipping the car into the chute; (3) raising and lowering the chute; (4) changing the inclination of chute; (5) hoisting and lowering the crane bucket; and (6) swinging the crane boom.

The total weight to be handled on the platform, including its own weight and that of a loaded car, is 44 tons, partly counterbalanced, which is handled at a velocity of 0.33 metres per second. For this work an electric motor of 130 h. p. is provided, operating a windlass provided with double-spiral drum, from which wire cables are led to the top of the tower. A 60 h. p. motor is provided for the tipping of the platform, while a motor of 17 h. p. is arranged to be connected either with the windlass for hoisting the chute, or with that for varying its inclination.

The whole of the operating mechanism ot the tipple is controlled from a small cabin, placed upon the top of the tower, where all the conditions can readily be seen. The operator stands between the controlling levers, one of which sets in motion the hoisting and lowering mechanism of the platform, and the other controls the tipping. The adjustment of the chute is regulated separately, this only being changed at considerable intervals.

The coal car is drawn upon the platform by an electric windlass, bolted fast, hoisted, tipped, lowered, and drawn away, these functions being controlled by three men, one in the cabin above, and two below.

In 1898 there was handled at the port of Rotterdam 350,000 tons of coal, but in 1899 this fell to about 260,000 tons, and with the present facilities the demands can probably be met for some time.

The advantages of electric power in such work are plainly shown in this interesting installation, the ability to remove the operative machinery to a place of shelter and protection, and at the same time permit the operator to be placed in full view of the work, with command of all the controlling mechanism, being a most valuable feature.

The Incandescent Gas Burner.

WHEN the introduction of the electric light gave a powerful competitor to gas lighting, the first attempts to meet the rival were based upon methods of giving a higher illuminating power to the gas flame itself. These consisted mainly in enriching the gas by suitable carburetting, and also, as in the Siemens regenerative burner, by greatly increasing the temperature of the combustion.

About 1885, however, the researches of Dr. Auer showed that great progress might be made along a new line, namely that of providing some other incandescent material besides the carbon contained in the gas itself, and the result was the well-known Auer, or Welsbach, incandescent mantle. In view of the progress which this form of gas light has made, the paper recently prepared by Herr Franz Bössner, and published in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines,* upon the theory of the incandescent gas light is of importance.

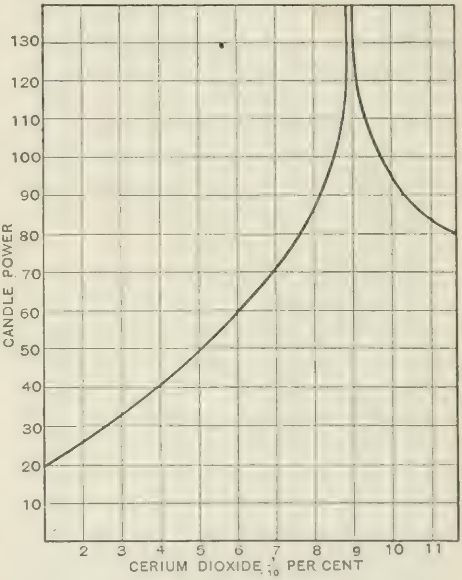
The use of solid incandescent materials for the production of light from heat originated long before the experiments of Auer, but with him began the practical use of the oxides of the so-called rare metals of the earth. The early mixtures employed consisted of varying proportions of oxides of lanthanum and yttrium, together with magnesia or zirconia, there being generally 60 per cent. of magnesia or zirconia with 20 per cent. each of the rarer oxides. Besides the above materials the oxides of thorium and cerium have been employed, and in the later incandescent mantles these latter oxides are used almost exclusively.

According to the investigations of McKean the following illuminating values are obtained for the various oxides, with a consumption of three cubic feet of gas per hour under a water pressure of one inch:

	Candles.	Color.
Oxide of Thorium	3.56	Blue-white.
Oxide of Lanthanum	28.32	White.
Oxide of Yttrium	22.96	Yellow-white.
Oxide of Zirconium	5.36	White.
Oxide of Cerium	5.02	Reddish.

Under these circumstances it is not surprising that the first attempts at the construction of an incandescent mantle should have been made with materials showing such high illuminating power as the oxides of lanthanum and yttrium. Experience, however, has shown that materials which emit but little light singly may become brilliantly incandescent when heated together. Thus thorium and cerium are among the lowest in the above table, and yet analysis of the most brilliant mantles made under the later Auer patents of 1893, shows the composition to be about 99 per cent. of oxide of thorium and 1 per cent. of oxide of cerium.

In studying the theory of this action several points are to be considered. Does the emission of light consist as a peculiar property of a material, or mixture of materials? Or, does it consist in a capacity for internal molecular motion, by which latent energy is released to appear in the form of light? Certain analogies in acoustics may here be noted. The flame of the Bunsen burner may be likened to a certain note, the vibrations of which correspond to those of but a single tuning fork capable of vibrating in unison with it. In like manner the slight admixture of oxide of cerium may act to bring the oxide of thorium into synchronism, so to speak, with the vibrations due to the temperature, so as to permit the conversion of the greater part into light.



The catalytic action of certain substances, by which they facilitate the combination between other bodies without undergoing any permanent change themselves, is well known. Thus there may be, according to Hehner, a continual dissociation and recombination of the two oxides, but this view does not appear to be confirmed by the experiments of Bunte. These latter experiments, in which the various compounds used in incandescent mantles were exposed to the heat of the electric current, appeared to show that the action of the oxide of cerium acted to separate the particles of oxide of thorium and permit the latter to be raised to a high degree of incandescence, just as a very fine platinum wire is raised to a white heat in a flame which will bring a heavier wire merely to a dull red.

The experiments of Le Chatelier and Boudouard show the material used in the Auer mantle to be feeble in emitting heat rays, while the Bunsen burner, on the contrary, emits much heat and little or no light. The Bunsen flame and Auer mantle are rich in yellow, green, and blue, but very weak in the red rays and in the infra-red rays of the dark spectrum, and since the red rays represent a large proportion of the energy, this may have an important bearing upon the theory of the incandescent mantle.

The diagram, after the experiments of Dr. Drossbach, shows the influence of varying percentages of oxide of cerium upon the luminosity of the mantle. The horizontal abscissas represent tenths of a per cent. of cerium di-oxide to thorium oxide in the mantle, and the vertical ordinates represent the corresponding candle power.

The Heating of Railway Carriages.

Since the exposition of 1889 there has been great progress in the improvement of railway material, and a comparison between the exhibits of that exposition and the one recently closed at Paris, shows very clearly the progress which has been made. Among the various elements which go to make up the comfort of the traveller by railway, no one is more important than that of proper warming, and this subject is very fully treated in a series of papers recently published in *Le Génie Civil,* prepared by M. H. Guérin, the engineer in charge of the department of lighting and heating of the Northern Railway of France.

Of modern systems, three distinct kinds may be mentioned—hot-water, steam, and electricity.

Hot-water heating, as employed on the Northern Railway of France, is accomplished by what is termed the "thermosiphon" system. This is very similar to the apparatus used for hot-water house-heating, modified by the peculiar conditions existing in railway service.

The boiler, with central cylinder for the fuel, and either spiral or annular water space, is placed underneath the carriage near one side, and the water circulates through flat radiators placed in the floor of each compartment, an expansion tank being placed in the upper part of the carriage above the boiler. The boiler can be fed from without, when the train is at rest, when the ashes can also be shaken down through the grate. The fuel at first used was gas coke, but this has since been replaced by anthracite, with improved results.

Heating by steam has been employed in Germany, Austro-Hungary, and Switzerland, radiators being placed under the seats, and so arranged as to permit a circulation of air, this being an important difference over the hot-water system, which mainly provides warm places for the feet, and considers the general heating of the air as a secondary matter. The steam is taken from the boiler of the locomotive, the pressure being controlled by reducing valves, and steam traps being employed to remove the water of condensation.

The so-called "mixed" systems are interesting, water and steam being used in connection. Thus, in the Körting system, used in the sleeping cars of the Compagnie des Wagons-Lits, the water is made to circulate through the system by the propulsive force of a Körting injector, the steam at the same time being condensed and thus heating the water. This gives the advantages of hot-water heating without the inconvenience of separate boilers, the steam for the injectors being taken from the locomotive boiler.

On the Eastern Railway of France the Lancrenon system, employing steam and compressed air, is used. The air, not condensing, maintains a circulation and carries the water of condensation along with it, while the temperature cannot fall below that of saturated steam at the pressure of the mixture. Another plan is adopted on the Paris, Lyons, and Mediterranean Railway; heaters containing water being placed in the floor of each compartment, and heated by steam circulating through pipes within the heaters, the water being stationary.

Heating by electricity is as yet but little employed, the only regular installations being those of the local railways in Belgium, and some isolated examples in Switzerland. In Belgium the compartments are heated by rheostats, but the energy expended is seven ampere-hours at 550 volts, per train of two carriages.

REVIEW OF THE AMERICAN PRESS

The Constitution of Cast Iron.

At one time it was supposed that the nature of cast iron could be determined by making a chemical analysis, but it was soon found that physical constitution and chemical analysis bore relations which were by no means easily understood. With the improved method of studying the physical constitution of metals, however, it has become possible to re-open the case, so to speak; and in the paper recently presented before the American Institute of Mining Engineers, by Professor H. M. Howe, the current opinions in regard to the constitution of cast iron are examined and discussed at some length.

Dr. Howe remarks that it is probable that the slow progress in learning the relation between the chemical composition and the physical properties of cast iron has been due to the fact that the problem has not been properly attacked. The hypothesis which he selects is that which assumes that composition governs properties in cast iron in the same general way as in the case of steel, and he then proceeds to extend the existing knowledge in the case of steel to cast iron.

Carbon steel, when cooled slowly, consists of ferrite, or pure iron, and cementite, or carbide of iron Fe_3C, the former being very soft, the latter very hard. In the case of steel, the inter-stratification of these two components produce the various results observed; in the case of cast iron, carbon in the form of graphite enters into the composition.

White cast iron is really similar in composition to steel, except that the carbon content has reached a higher limit, usually taken as somewhere between 2 and 3 per cent. Common, or graphitic cast iron, which consists of white cast iron as a matrix, containing a varying percentage of graphite.

In the case of white cast iron it is found that whereas the ductility diminishes and the hardness increases continuously as the carbon increases, the tensile strength increases only until the carbon reaches about 1 per cent., and then in turn decreases.

With graphitic cast iron, when the graphite is constant and the combined carbon varies any increase in combined carbon should cause an increase in hardness and a decrease in ductility, the tenacity increasing until the combined carbon reaches 1 per cent. When the combined carbon remains constant and the graphite varies, the strength, ductility and hardness should all decrease with the increase in graphite.

With ordinary foundry irons the total carbon varies but little so that as the combined carbon increases the graphite decreases. Examining the various combinations of ferrite, cementite, and graphite according to the methods of metallography, Professor Howe shows the important influence of the nature of the carbon present upon the physical constitution and the properties under test. This is readily seen from the respective properties of the constituents. Ferrite is soft, ductile, and copper-like; cementite is brittle, and almost glass-hard, while graphite is soft and granular.

In examining the question of the constitution of the strongest cast iron Professor Howe shows that there is an increase in tenacity for a carbon content up to 0.80 per cent., and a decrease as the carbon rises beyond 1 per cent. This would lead to the idea that an important line of progress would be the production of cast-iron castings lower in carbon than our present ones. This, however, must depend, as has already been shown, upon the distribution of the carbon between the states of graphite and cementite, and by conditions of melting, etc.

In this connection some interesting facts are given as to the relative strength of cast iron melted in a reverberatory furnace and in a cupola, these showing the air furnace castings to be decidedly the stronger. Since the cupola is a carburizing furnace and the air furnace a decarburizing one this bears out Professor Howe's hypothesis, In regard to the influence of ferro-silicon upon the product of the cupola Professor Howe has somewhat to say:

"The notion that the addition of ferro-silicon increases the quantity of scrap which a cupola charge can carry has been ridiculed. It is however eminently reasonable. When scrap iron is melted in the cupola furnace it tends to lose silicon without correspondingly losing carbon, for the simple reason that, while the silicon which is burned away as the iron drops past the tuyeres cannot be readily restored in the cupola, the carbon simultaneously burned away is so restored.

"Now the removal of the silicon tends to diminish the graphite in the resultant casting, and thereby to increase the quantity of combined carbon; thereby to increase the cementite; and thereby to make the resultant castings harder and more brittle. The addition of ferro-silicon raises the silicon in the castings; thereby increases the graphite; and thereby diminishes the combined carbon. Or, it is probably more accurate to say that the addition of ferro-silicon diminishes the amount of combined carbon by lowering the solvent power of the solidifying iron for carbon, thus forcing part of the carbon out of combination into the form of graphite, and this reduction of the amount of cementite, or of combined carbon, softens the castings. One would naturally suppose that even a charge of scrap cast iron alone could readily be converted in good gray castings by the addition of a sufficient amount of ferro-silicon. Such a charge of scrap, when melted, would in any event have sufficient carbon to make it brittle and intensely hard, provided no silicon at all were present. The addition of ferro-silicon should diminish the combined carbon in such castings, and this itself would make the castings softer."

"Mr. W. J. Keep finds the most conclusive proof that the existence of combined carbon has no influence, unless to weaken a casting by making it brittle,' and as regards graphite, that 'strength or weakness seem to be absolutely independent of this element.' These inferences he draws from a great number of cast irons varying but little in total carbon. In such a series, as the combined carbon increases, the graphite must decrease; so if both the combined carbon (in excess of 1 per cent.) and the graphite weaken and embrittle the cast iron, the effect of the increase of one in such a series as his might be masked by the effect of the simultaneous decrease of the other. Thus one might very readily be led to Mr. Keep's conclusions, and fail to note that they are probably true only for approximately constant total-carbon. While it may be true that, for any given percentage of total-carbon, as in his data, variations in the condition of that carbon have relatively little influence (the state of cementite injuring the strength about as much as that of graphite), this is no evidence that each of these substances by itself is harmless. It would be about as logical to infer that neither graphite nor combined carbon weighed anything, because changing carbon from one state to the other did not affect the weight of the cast iron as a whole, as to infer that neither separately effected the strength or ductility, from the fact that shifting the carbon from one state to the other does not greatly affect those properties. The resultant of two equal and opposite forces, no matter how powerful, is zero."

Waste in Water Supply.

The recent convention of the American Water Works Association in New York was the occasion for the presentation of several papers bearing upon the question of waste water supply in cities, the most important of these being contributed by Mr. Clemens Herschel, the well-known hydraulic engineer, others being by Mr. H. C. Hodgkins and S. J. Rosamond.

Mr. Herschel starts out to prove what at first appears to be an altogether self-evident proposition, that "thrift in the operation of water works is more economical than waste!". He takes this position because of the very general practice of proceeding on the contrary basis, and assuming that the proper thing in nearly all cities is to permit all the waste possible, and then extend the water works to supply the deficiencies caused by waste. This absurd position becomes more evident than ever when water purification schemes are considered and when millions are designated for the construction of water-purification plant when 75 per cent. of this expensively treated fluid is afterwards to be permitted to run away unused.

"It often becomes, and will continue to be desirable to purify water before it is delivered, but the enormous quantities wasted render such purification works very difficult to encompass. The cost becomes extremely burdensome when added to the already great cost of delivering these extravagant quantities of water under fire pressure, at the tap of the consumer. The large quantities drawn, mostly waste, cause the street mains and other conduits to become too small for the service demanded of them; this causes a lack of fire pressure, and great sums of money are constantly demanded for the purpose of furnishing larger mains and other conduits. The water originally delivered, now becomes sewage, is cast in huge volumes into the nearest water course —an entirely unlawful proceeding. be it noted, unless the receptacle be a tidal stream. It were well to purify this sewage, and communities can always be compelled by law to purify it, but its enormous volume, mostly waste, renders such purification nigh impracticable.

"So the sewage is allowed to pollute streams which should be the sources of city water supply, and thus natural bodies of water fit to be the sources of such water supply for the same, or for other cities, are made difficult to find, and these water-supply works are made many fold more expensive than need be—all this, it will be observed, to the end that needless waste may continue."

Mr. Herschel then proceeds to show how waste may be averted, or at least greatly diminished, by a judicious system of metering. Meters on the house service pipes should certainly be employed in all cases, and in the papers of both Mr. Rosamond and Mr. Hodgkins will be found interesting information as to the detection of local leaks by the use of meters. Householders should be taught to welcome meters as means of reducing their own payments for the wastefulness of others, as in nearly every instance the heavy wastes occur in manufacturing establishments, the cost being divided up among the community when meters are not used. District meters also render much service in detecting leaks in mains, since the readings during the night hours, when there are no demands upon the house services, will give clues as to wastes of this kind. The only reasonable way of diminishing waste is to apply the same common-sense method as is used in other kinds of work; to measure what goes in and what comes out, and charge people for what they receive, whether they use it or not. Such a rule, properly carried out, would soon cause waste water to disappear, and so far from injuring public health, since it would enable it to be greatly improved, it would permit the introduction of both water and sewage purification plants at reasonable cost, where now the expense is prohibitory.

There is, of course, one side of the case to which the work of the engineer does not apply, namely the fact that it is to the interest of those politicians who benefit by increased public expenditures, to permit those expenditures to be as large as possible. Since water-works engineering is almost invariably mixed up with politics it is evident that waste will not be restricted unless the politicians' side of the question can be settled satisfactorily. Since political engineering is beyond the scope of this publication, this branch of the subject cannot be dealt with here, but its existence must be well known to all hydraulic engineers who have approached the water-waste problem.

The Transactions of Technical Societies.

Associations and institutions of professional men fulfil many valuable functions, and their progress and prosperity is greatly to be desired for many reasons. Naturally the prinicipal object of such bodies is to promote the friendly relations of the members to each other and permit the interchange of opinions and experience which could otherwise hardly take place. With these advantages also come the benefits gained by the contributions of papers upon professional topics, and these papers usually extend the information and experience of the members to interested readers at large, either through the medium of published transactions or through reprints in the technical journals.

The recent convention of the American Railway Master Mechanics' Association at Saratoga was the occasion of the appearance of a number of papers which came so disappointingly near being of much value that some discussion of the manner in which such papers are prepared may be permitted, together with friendly criticism of their shortcomings.

Thus, for example an apparently very complete paper upon the important question of the "Cost of Running Trains at High Speed" is received, and coming from a body of men so close to the actual facts as the Master Mechanics, one can hardly be blamed for expecting to find much valuable information upon this mooted topic.

Upon examination, however, the paper shows that it has been produced in the following manner. The question having been proposed, it was referred to a committee of three members especially competent to discuss it most intelligently. This committee sends out letters to the officials of important roads operating high-speed trains, together with a schedule of questions, answers to which would undoubtedly furnish valuable material for the work of the committee. So far, this is most excellent. When the information is received, however, instead of being digested and edited so as to eliminate all irrelevant matter and collect the reliable data in comparative form, it is simply printed in a string, without arrangement or analysis, and apparently without especial weight as to comparative value. As a consequence, the seeker for information is obliged to do for himself what the committee in charge of the matter should have done for him, and lacking their experience and familiarity with the subject, much of his effort is wasted. The work was so well started, that one cannot but regret that it was not properly completed. Similar conditions appear in other papers presented before the convention, and this leads to the question as to the best method of preparing professional papers for technical meetings in general.

The original idea of a professional paper was that it should be distinctly personal and representative of the professional work and knowledge of the writer. This is most desirable when it can be secured, although in practice the "but" is a large one. The ablest professional men are often too busy, and it is difficult to induce them to contribute to society transactions matter which forms an integral part of their regular business. Again many men of eminence in successful practice have not that facility in writing which lends itself to a ready account of matters about which they know so much, and if that facility is not always found among professional engineers, it can hardly be expected among master mechanics and superintendents, although these are often the men whose experience would be most eagerly welcomed by the profession.

Papers prepared in collaboration have often been most successful. Indeed it is not uncommon to find papers presented by professors and instructors with the distinct acknowledgment of the valuable assistance which has been rendered in investigation and computation by students and subordinates, under the direction of the superior. This leads directly to the committee method, as undertaken by the Railway Master Mechanics, with the important difference that the paper is avowedly prepared by a responsible head, by whom the matter is digested and edited in shape for discussion and practical use.

It is the general experience in technical societies that the best papers are usually those which elicit the most discussion, and discussion can hardly be had intelligently upon a paper which is not in form for ready assimilation and use. It was at one time suggested in one of the national societies that the author of each paper be requested to furnish with it a systematized abstract for use in presenting the subject before the meeting, when the point at once arose, that in that case there would be no necessity for the paper itself, the abstract becoming in fact the paper.

By all means let the custom of sending out correspondence upon technical subjects for society papers be continued, but let it be understood that the chairman of each committee having such work in hand act as editor of the matter received, placing it in formal and systematized shape for discussion and criticism, so that the valuable matter thus collected may be made immediately available.

An excellent lesson in this line may be obtained from the manner in which the papers, or reports, are prepared in connection with the international engineering congresses held in connection with expositions.

Committees are appointed, generally from the numbers of experts in the respective subjects, and these committees send out data and receive information and correspondence, this material being then discussed in committee and incorporated into reports which practically comprise the latest word upon the various subjects.

The principal function of such committees is editorial, and the result is that the reports form the most valuable additions to current technical and professional literature which can be obtained. The technical societies have done much good work in the past, even with the crude methods employed in some instances, and with but little modification these methods may readily be converted into the most efficient system possible for providing valuable contributions to technical knowledge.

The Status of the Civil Engineer.

At the recent convention of the American Society of Civil Engineers the perennial question as to the possibility of doing something to limit the practice of civil engineering to such as may be in some manner officially qualified, came up once more.

It was again formally announced, in a communication from a highly esteemed member, that anyone may practice civil engineering without special permission, if he can be so ingenious as to find anyone upon whom he can practice. This deplorable state of affairs was compared with the far more desirable arrangement existing in the professions of medicine, law, and divinity, (everyone knows that there are no shyster lawyers, quack doctors, or fake clergymen), and hence the importance of remedying this great evil. Legislation was called for in order to enable the engineer to have his calling restricted to competent men "out of a spirit of loyalty to the profession!"

This would all be most amusing if it were not propounded in such a spirit of serious solemnity. A body of men, most of whom have risen to eminence in the great profession of civil engineering because of the very freedom with which they were allowed to enter it, and mount to its highest honors by their own efforts, is urged to call for legislation "out of loyalty to that profession," and bar the entrance through which most of its members came. Hardly less amusing are the suggestions which were made as to the manner in which the bars should be put up. First of all the exact meaning of the term civil engineer should be defined. From this it would appear that the members of the esteemed society referred to have as yet been in ignorance of what they really were, a most deplorable condition of affairs. Second, a state board of examiners should be appointed; thus making entrance into the profession possible by systematic cramming for "exams," such as prevails in practically all methods of grading by examination. Third, licenses to be handed out; these to be in three grades, according to the degree of "eminence" of the handee. How the degree of eminence is to be determined is not stated. Fourth, heavy punishment to be provided for anyone attempting to practice without a license, no matter how well his work may be done. Fifth, and most convenient, a provision to be made to let in without examination all those who have been in practice for 15 years, as well as such others as may show evidence of their attainments. This provision is the most ludicrous of all, since these are the very men who, if their pretensions were at all well founded, should not have the slightest difficulty in passing an examination. Seventh, the revoking of licenses for unprofessional conduct. What constitutes unprofessional conduct, and by whom decided, not stated.

Discussion on this latest development of a time-worn topic is indeed unnecessary, and the Society certainly did the right thing in referring it to a committee, by whom it is to be hoped it will not be treated more seriously than it deserves.

The Principles of Cost Accounting.

There is probably no one feature in the modern development of skilled works-management which has attracted so much attention of late as that department which relates to the correct determination and apportionment of factory costs. The popularity of recent articles in the pages of this magazine bears witness to the desire of works managers to familiarize themselves with the practice of various establishments, while the extent to which the subject has been treated elsewhere indicates the prevailing interest.

An excellent contribution to this branch of technical literature is found in the address delivered by Mr. F. A. Halsey before the mechanical engineering students of Cornell University, and published in recent issues of the *American Machinist.*

Mr. Halsey first calls attention to the difference between cost keeping and ordinary bookkeeping. The latter is always very precise even if not always accurate, and it is often more concerned with the form than with the substance of the transactions which it records. There is a fictitious appearance of exactitude based upon elements which must always contain a large element of guesswork. The engineer, on the contrary, is accustomed to work within certain limits of error, and is more concerned with facts than with the precision of the form in which they are recorded.

The cost of a machine to its producer is composed of three items—material, labor and burden. The term material explains itself, but labor is here used in a restricted sense, and means the wages of those operatives whose time is so spent that it can be accounted for and charged to the separate articles made. Such labor is properly defined as direct labor, though more commonly called productive labor. By burden is meant a factor which is added to the cost of material and direct labor to cover such items of the cost of production or of the conduct of the business as cannot be directly charged to the individual pieces produced. The burden is made up of many items, such as the cost of rent (if the business is conducted in rented quarters), of salaries, power, heat and light, insurance, taxes, and what is properly called indirect labor, though more commonly, but erroneously, called non-productive labor—by which is meant the labor of men who appear on the weekly pay rolls, but whose labor is of such a nature that it cannot be directly charged to any individual article produced for sale. Among such men are the foremen, the engineer or fireman, and many of the helpers or laborers about the shop, crane operators, etc.

As Mr. Halsey says, the problem of cost accounting resolves itself principally into burden accounting, and as it is found that the burden is rarely less than 100 per cent. of the wages, this is as important an element as the direct wages account. The total burden is not difficult of determination; fuel, interest, rent, insurance, depreciation, can all be made matters of record. Indirect labor may be recorded by keeping a daily running account to which all labor is charged for which no order number can be found, and the total taken and added to the burden whenever an inventory is made.

Two methods have been devised for the distribution of the burden; the percentage plan and the hourly-burden plan.

"Under the percentage plan the gross burden for a given period is divided by the gross direct wages for the same period. The resulting ratio, treated as a percentage, gives a factor which, when multiplied by the direct wages on any piece of work will give the burden belonging to the work, and this added to the direct wages will give the final labor cost.

"The great special shortcoming of this plan is that it ignores the element of time, which is a necessary factor. It is obvious that the burden properly chargeable against a given tool would be twice as much for two hours as for one, and yet were a job done to-day by a two-dollar man and to-morrow by a dollar-a-day boy, the boy using the same tool, but consuming twice the time of the man, the wages would be the same, and hence the burden also. This is clearly wrong, since the boy having used the tool twice as long as the man, the burden charged against him should be twice as great. The percentage lan has the advantage of simplicity, as after the wages are calculated for each time ticket, the element of time is lost sight of, all succeeding records and accounts being in dollars only.

"Under the hourly plan the gross burden for a given period is divided by the total number of hours of direct labor for the period, the quotient being a charge per hour which is to be added to each hour's wages on a given piece of work to obtain the labor cost of the work. Taking the previous illustration again, it is clear that the hourly plan would charge the boy with twice as much burden as the man, as it clearly should."

The difficulty with the hourly burden plan lies in the fact that it does not meet the interest and depreciation charge. This is a matter of minor importance with small tools, upon which these items bear but a small ratio to the labor. With large tools, however, it is different, and under such circumstances it is necessary to make some provision for the interest and depreciation apart from the hourly burden if a fair distribution is to be made.

"When the subject comes to be considered in detail it soon appears that there are other items besides interest and depreciation which should be considered in this connection. The burden may in fact be considered as composed of two burdens—the man burden and the tool burden—since some of the expense is incurred because of the men and some because of the tools. For instance, heating and lighting are needed by the men only, since, as far the tools are concerned, they could do their work just as well in the cold and dark. On the other hand, the power is consumed by the tools. Some items are not easy to classify or divide. For instance, both men and tools need protection from the weather, and the charges on the building are thus properly chargeable in part to both, though just how the division should be made is not easy to decide. Insurance on the tools themselves is of course chargeable to them only, whereas insurance on the buildings is chargeable to both tools and men. The expense of superintendence and foremanship, except as it relates to the installation of new tools or to repairs, is obviously chargeable to the men."

Mr. Halsey is inclined to be rather conservative in the matter of deprecation and although he admits that in such plants as rolling mills and the like, where improvement is rapid and revolutionary, the life of the plant is estimated at ten years, he assumes in general a useful life of twenty years for machine tools. This may be safe, but it is hardly wise to make any rule, and the better plan is to decide each case on its merits, and incline rather to too great rather than too little deprecation.

It is a healthy sign of the times when it is realized that such subjects are being discussed before engineering students, and the work of the machine shop of the immediate future will doubtless be all the better for the familiarity with shop accounting possessed by the men to whom the conduct of such establishments must soon be intrusted.

The Regulation of the Mississippi River.

River improvement works are usually designed with the especial intention of protecting the banks and maintaining a reasonably constant channel, but with this comes also the important question of the protection of the water fronts of cities.

In a recent issue of *Engineering News* is a paper by Mr. L. W. Brown upon the protection of the water fronts of cities in the Mississippi valley, which contains some interesting views, here given in abstract.

The method adopted by the Mississippi River Commission twenty years ago is that known as the spur-dike and mattress system, and although it has been successful in many instances, it does not always produce satisfactory results. Spur dikes sometimes fail in their purpose because it is the practice to place them directly in the apex of a caving bank, in which position they form a true dam, decreasing the sectional area of the stream and checking the flow until a sufficient head is produced to increase the velocity and permit the given volume to flow through the contracted channel. This produces cross currents which set against the banks, producing erosion and caving. Mattresses are only efficient when the work is begun at the point where the abrading commences, and continued smoothly along the entire surface to be protected.

The pile bank protection, advocated by Mr. Brown, practically consists in the construction of a system of braced piling, with tops above maximum flood heights, and extending out into the stream to such a line as will best receive and guide the current past the abrading stretch, providing a depth of 30 feet or more of flood river to impinge against the piles. The outer, or bulkhead row of piles form a water-tight sheet piling, and the whole forms a support for the levee. This construction stops the abrasion and causes accretion to commence, while an earth filling can gradually be put in and a new slope bank constructed before the front bulkhead has deteriorated to such an extent as to require renewal.

"The advantages claimed for this system of pile protection are, that it extends continuously from the upper end of an abrading bank far enough into the bend to throw the current away from the shore. It extends sufficiently high into the highest flood line and far enough out into the river to affect 30 or 40 feet in depth of river at high water. The piles are placed at uniform distances apart and provide a uniform resistance to the current striking them. The front or river line of the work is placed on a line best adapted to receive and guide the current past the bank where abrasion was previously taking place.

"The whole theory of the success of work of this type is that a safe and uniform velocity is given to the river current; eddies, cross currents, etc., are obliterated, and the uniform resistance of the piles to the flow checks the current sufficiently to allow suspended matter to be deposited on the bank previously abraded. Finally, the extent of the possible movement of the river bed towards the opposite shore is only limited by the gradual extension of the pile protection work into the river."

Coaling by Machinery.

THE coaling of vessels is always a tedious undertaking, and from its nature is generally performed by hand. Time will rarely permit the taking of a vessel to the coal docks to receive the coal through chutes leading directly from the coal bins, and in any case the coal cannot be received faster than it can be stowed and trimmed in the ship's bunkers. The general practice therefore, is for each vessel to receive coal from barges brought alongside while the ship is lying by its dock.

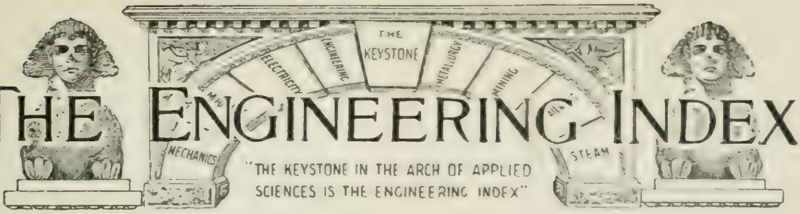
There has recently been placed in operation in New York an improved form of coaling barge which appears greatly to facilitate the tedious work of coaling from barges, and from an account in the *Iron Age* the following description is abstracted.

The usual method of transferring the coal from the barge to the steamer is to shovel the coal by hand into baskets, bags, or iron buckets on the barge, these being lifted by a whip hoist, operated from the steamer, and lowered and dumped into the bunker opening. Here it slides down a chute into the bunker, where it is stowed in place by the trimmers, this work being most exhausting in the unventilated bunkers.

"By the new method the coal is contained in a steel barge of 1,000 gross tons capacity, divided by transverse bulkheads into several compartments or coal bins. The floor of each bin is raised above the bottom of the barge, to accommodate a passageway which runs the whole length of the bins, just above the keel, and in which a train of buckets is drawn by an endless chain composed of flat steel links. There are three square openings in the bottom of each bin, closed by sliding doors, and as each hole is opened the coal lying above it slides down into the buckets. The train of buckets is moved by means of a steam engine in the rear compartment of the barge, through the horizontal passageway, then vertically upward in a tower which contains two automatic weighing and recording scales, into one of which each alternate bucket is dumped. The coal then slides from the scales into two telescopic steel tubes, which deliver it into the bunkers of the steamer. The principle of the coaling barge is therefore similar to that of the well-known floating grain elevator, but the machinery is much heavier and contains many devices to facilitate the handling of a somewhat intractable material like coal.

"The barge delivers the coal steadily at the rate of 125 gross tons per hour, and has been operated for several hours at a time at a rate of 135 tons. The whole operation is almost noiseless and free from dust, and it is accomplished entirely by the machinery of the barge, without any hand labor and without the assistance of any of the machinery or crew of the steamer."

There is no doubt that this apparatus greatly facilitates the handling of the coal, so far as its delivery to the bunkers is concerned, and to this extent it is an undoubted improvement. What is now needed is some improved form of stowing which will relieve the trimmers. This will doubtless involve an entire re-arrangement of the bunker system, and many objections to any such would doubtless be made by ship-owners and masters. Such exhausting and brutalizing labor, however, demands every possible effort to secure its amelioration, and improvement must ultimately come. When to this is added a satisfactory form of mechanical stoker for marine service, the most objectionable features of steam navigation will have disappeared, and both problems are before the mechanical engineers of Europe and America for solution.



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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Bascule.

A Long Span Bascule Bridge Over the Chicago River. An illustrated account of interesting bridge construction, with statement of conditions. 1000 w. R R Gaz—June 7, 1901. No. 41538.

Concrete.

The Northampton Concrete Bridge, Central Railroad of New Jersey. Illustrated description of a three-track railway arch with spans of 52 and 34 ft. The bridge was built without interfering with traffic over the truss spans which it replaced. 2000 w. Eng Rec—June 8, 1901. No. 41462.

Floor.

Floor System of the New East River Bridge, New York. Cross-sectional views, giving an idea of the carrying power of this new bridge, with description of the stiffening trusses, constructed on the riveted system, and the horizontal system of trussing to resist wind-pressure. 1600 w. Sci Am—June 15, 1901. No. 41588.

Girders.

An Enclosed Plate-Girder Park Bridge. Illustrated description of a steel bridge covered with concrete to give the appearance of masonry, built on the Vanderbilt estate of Biltmore from the plans of Richard M. Hunt. 800 w. Eng Rec—June 1, 1901. No. 41341.

I-Beam Girders with Re-enforcing Plates. C. F. Blake. Chart and tables convenient in the calculation of the strength of I-beams re-enforced with cover plates upon the flanges, with explanation. 400 w. Am Mach—May 30, 1901. No. 41295.

Inspection.

Bridge Inspection. George H. Burgess. Considers the methods of inspection of steel bridges only, describing the ordinary practice. 2500 w. Wis Engr—May, 1901. No. 41385 D.

Iron Bridges.

The Development of Iron Bridge Construction. Charles S. Davis. A brief review of this work and outline of the methods of conducting the business of a bridge plant, and the need of rapid methods of calculation. Ill. 2200 w. Trans Assn C. E. Cornell Univ. 1901. No. 41387 D.

New York.

Substructure for the Fourth East River Bridge, New York City. Abstract of the specifications for material and workmanship are given, with illustrations of details. 2600 w. Eng News—June 20, 1901. No. 41816.

Niagara.

The Horizontal Thrust of the Niagara Falls and Clifton Arch. R. A. Pendergrass. Mathematical determination. 1000 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41390 D.

The International Bridge, Buffalo. Illustrated description of the method of removing the spans of a bridge across the Niagara River and replacing them with heavier spans without any material interruption of passenger traffic. 2500 w. Eng Rec—June 15, 1901. No. 41557.

Railroad Bridges.

New York Central Bridges. Charles N. Green. An illustrated article giving in-, formation of designs and methods used in the extensive reconstruction work of the road named. 2500 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41394 D.

Spain.

The Cabe Bridge (Puente del Cabe). José María Sáinz. Description in detail of a new bridge, 40-metre span, to carry the highway from Monforte to Lalín across the Cabe river at Chantada, northwest Spain. 2500 w. 2 plates. Revista de Obras Publicas—June 13, 1901. No. 41780 D.

Standards.

Short-Span Railway Bridge Standards. Explains the method of the Santa Fe Railway for systematizing its bridge work. 700 w. Eng Rec—June 15, 1901. No. 41559.

Test.

Test of the Bridge at Heusden (Beproeving van de Brug bij Heusden). H. van Oordt. Report of official test, with description of instruments for measuring deflection, and tabulated results. 10000 w. Tidschr v h Klik Inst van Ing—Feb. 9, 1901. No. 41765 H.

Transfer Bridge.

Standard Transfer Bridge for Car Floats—New York Central & Hudson River Railroad. Illustrated detailed description of the method of transferring cars from the float to the shore, including the construction of the bridge, apron and operating machinery. 1700 w. R R Gaz—May 31, 1901. No. 41312.

Viaduct.

Double-Track Railway Viaduct Over the Des Moines River. Illustrated description of a viaduct nearing completion, remarkable for the combination of height and length. 600 w. Sci Am—June 1, 1901. No. 41285.

Riverside Viaduct. John W. Ripley.

Illustrated detailed description of this fine viaduct in New York. 2600 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41396 D.

CANALS, RIVERS AND HARBORS.

Bar Removal.

Dynamiting Sand Bars. Reviews a report on an attempt to blast a channel through a sand bar at Brunswick, Ga., the work costing twelve times as much as dredging. 1600 w. Eng Rec—June 8, 1901. No. 41461.

Breakwater.

The Buffalo Breakwater. Thomas Symons. An outline of the development of Buffalo harbor, briefly describing some of the works now being built to provide for the accommodation of commerce. 7600 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41388 D.

Chicago.

Chicago Harbor. Robert B. Wilcox. A statement of the conditions, discussing the past and future improvements. 4000 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41393 D.

Dams.

Coefficient of Friction in Dam Design, and the Failure of the Dam at Austin, Tex. H. P. Gillette. Discusses the theories advanced to explain the failure of this dam. 2800 w. Eng News—May 30, 1901. No. 41305.

Some Dams Recently Constructed by the Spring Brook Water Supply Company. John H. Lance. Description of the larger of these dams and the methods employed. 5700 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41395 D.

Some Dams Recently Built by the Spring Brook Water Supply Company. Describes masonry dams 73 and 104 ft. high, of unusually heavy cross-section, and explains the method of carrying pipes through a 37-ft. earth dam on heavy masonry foundations. 2800 w. Eng Rec—June 15, 1901. No. 41558.

Dikes.

The Dikes of Holland. Gerard H. Matthes. Reviews the history of the building of the dikes, the reclaiming of the land, formation of lakes, and the engineering problems connected with the work. Ill. 7000 w. Nat Gaz Mag—June, 1901. No. 41375 C.

Dock Gates.

Gate Machinery for Mersey Docks. An illustrated description of hydraulic machinery. 3500 w. Engr, Lond—June 4, 1901. No. 41840 A.

Drainage.

The Drainage of Marajo Island (De Afwateringskwestie van het Eiland Marajo). H. L. van Hooff. An examination of the topography of Marajo island, at the mouth of the Amazon, showing the engineering work necessary for its reclamation by drainage. 15000 w. Tidschr v h Klik Inst van Ing—Feb. 9, 1901. No. 41764 H.

Dredges.

Hydraulic Hopper Dredges for Harbor Improvement at New York. Illustrated description. 1400 w. Marine Engng—June, 1901. No. 41529 C.

Dry Dock.

See Electrical Engineering, Power Applications.

Filling.

Filling in Tide-Water Flats at Seattle, Wash. Brief account of the work in progress. 1000 w. Eng News—June 13, 1901. No. 41586.

Flow.

A New Formula for Determining the Flow of Water (Studie über eine Neue Formel zur Ermittlung der Geschwindig keit des Wassers). R. Siedek. An examination of the formulas of Bazin and of Kutter, and the derivation of a new formula, especially applicable to rivers and streams. Serial, Part I. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—May 31, 1901. No. 41719 B.

Isthmian Canal.

An Isthmian Canal From a Military Point of View. Peter C. Hains. Full paper presented before the Am. Acad. of Pol. & Soc. Sci. Showing that a neutral canal is a more useful canal to the United States than one controlled by military power. 4000 w. Jour U. S. Art—May-June, 1901. No. 41601 D.

Java.

A General Plan for the Irrigation of Java (Een Algemeen Irrigatie-Plan voor Java). H. H. van Kol. A comparison of the conditions of Java with those of British India, and a recommendation of the adoption of a consistent irrigation system for the whole island. 3500 w. De Ingenieur—May 25, 1901. No. 41770 B.

Mississippi.

The Protection of Cities in the Mississippi Valley Against the Encroachment of the River. L. W. Brown. An illustrated study of the conditions and the systems of protection thus far tried. 3700 w. Eng News—June 13, 1901. No. 41579.

Prussian Canals.

The Prussian Canal Projects. Editorial discussion of the new schemes, their main features, and some particulars. 3600 w. Engng—May 24, 1901. No. 41366 A.

Rhone.

The Motive Power of the Upper Rhone (Les Forces Motrices du Haut-Rhône). A. Garcia. A study of the best method of utilising the hydraulic power of the Rhône in France between the Swiss frontier and Pyrmont. More than 160,000 h. p. is available. 10000 w. Mem Soc Ing Civ de France—April, 1901. No. 41728 G.

Scheldt.

The Improvement of the Scheldt in Belgium (Dei Verbetering van de Belgische Schelde). J. W. Welcker. An account of the plans for the improvement of the Scheldt between Antwerp and Fort Lillo, including the proposed cut-off. 8000 w. De Ingenieur—April 6, 1901. No. 41766 B.

Zuider Zee.

Reclaiming the Zuider Zee. A brief account of how this great work is to be carried out, with an estimate of the cost. 1100 w. Engr, Lond—May 31, 1901. No. 41497 A.

The Drainage and Reclamation of the Zuyder Zee (Afsluiting en Droogmaking van de Zuiderzee). A review of the financial and commercial conditions involved in the conversion of the Zuyder Zee into available land. 2000 w. De Ingenieur—May 25, 1901. No. 41771 B.

CONSTRUCTION.

Building Details.

Light and Air in Tenement Houses. Describes the conditions in New York tenement houses under existing laws, and gives notes of the conditions in 1878, when the subject first received widespread attention. 3500 w. Eng Rec—June 15, 1901. No. 41564.

Dome.

The Iron Construction of the Dome of the New Government Building at Bern (Die Eisen Neuen Bundeshause in Bern). F. Schüle. An interesting example of structural building construction, with plans and details and a view of the completed work. 1800 w. Schweizerische Bauzeitung—June 1, 1901. No. 41758 B.

Fireproof Construction.

Fire-Proof Building Construction. J. T. Richards. Discusses the materials used, the systems of construction, etc. Ill. 1800 w. Wis Engr—May, 1901. No. 41384 D.

Foundations.

Air versus Water. John F. O'Rourke. Discusses difficult work in building foundations, the methods used, etc. Ill. 4700 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41392 D.

Interior Lighting.

A New Era in Interior Lighting. Charles L. Norton. An account of the progress made in the use of diffusing glass, the changes due to its adoption, and some of the varieties. Ill. 4000 w. Tech Quar—March, 1901. No. 40976 E.

Lighthouse.

The Greens Ledge Lighthouse. Illustrated description of a new lighthouse being erected in Norwalk (Conn.) harbor, and the methods of construction. 1600 w. Ir Age—June 27, 1901. No. 41860.

Shield.

The Use of the Shield in the Construction of Tunnels (L'Emploi du Couchier à la Construction des Tunnels). An exhaustive critical study of tunneling by means of the shield, with accounts of numerous applications. Serial, Part I. 2500 w. Revue Technique—May 10, 1901. No. 41710 D.

Tunnels.

The Stralau-Treptow Tunnel Under the River Spree. Brief illustrated account of the first submarine tunnel ever constructed in Germany. 700 w. Sci Am—June 22, 1901. No. 41696.

Tunnel Lining Without Traffic Interruption. Willard Beahan. An illustrated account of work on the Musconetcong tunnel on the Lehigh Valley R. R. in the State of New Jersey. 3700 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41391 D.

See also Civil Engineering, Measurement.

Underpinning.

Supporting a Brick Wall From One Side Only. Illustrated description of the manner of underpinning a Boston building by raking struts, suspender rods and cantilever beams, so that the interior of the building was not affected. 900 w. Eng Rec—June 1, 1901. No. 41345.

MATERIALS.

Cement.

Cement in Canada, Latin America, and the West Indies. Information concerning the cement trade. 6000 w. U. S. Cons Repts. No. 1052—June 3, 1901. No. 41329 D.

Notes on Cement. J. R. Gardiner. A synopsis of what has been written on this subject, given in a concise form. 2000 w. Can Archt—May, 1901. No. 41326 C.

Notes on Cements and Cement Testing. Henry Fox. Gives a description of the raw materials in the composition, and a method of converting the same by means of a chemical and mechanical process into a fine powder of double silicate or calcium and alumina, and discusses methods of testing. Ill. 6700 w. Wis Engr—May, 1901. No. 41383 D.

The Manufacture and Testing of Portland Cement. Walter E. Bush. This paper gained a special prize offered by the Cement Users' Testing Assn. Reviews the history of the inception and progress of this material, the manufacture, the kilns and grinding machinery, and methods of testing. 5000 w. Quarry—June 1, 1901. No. 41594 A.

The Setting of Portland Cement. Gavin J. Burns. Diagram showing the microscopic appearance while setting, with description of the process whereby the cement is converted into a solid mass. 1200 w. Builder—June 15, 1901. No. 41827 A.

Cement Mortar.

The Use of Trass and Puzzolana With Portland Cement Mortar (De Toevoeging van Tras en andere Puzzolanen aan Portlandcement Mortel). H. Wortman. With record diagrams of tests, showing the economy and advantage of a judicious admixture of puzzolana. 3000 w. De Ingenieur—May 18, 1901. No. 41769 B.

Concrete.

Concrete Construction. C. R. Neher. Practical suggestions from the standpoint of the purchaser and contractor, as well as the engineer. Ill. 3000 w. Jour Assn of Engng Socs—April, 1901. No. 41292 C.

Concrete-Steel.

An Accident to a Concrete-Steel Grain Bin. Illustrated description of a bin which burst when filled with grain; the walls were of concrete reinforced by rings of strap-iron. 600 w. Eng Rec—June 1, 1901. No. 41342.

Granites.

The American Granites. A summary showing where the main deposits now being worked are formed, and information concerning the varieties and quality. 1600 w. Stone—May, 1901. No. 41698 C.

Serpentines.

The Serpentines of Manhattan Island and Vicinity and Their Accompanying Minerals. D. H. Newland. Concerning their distribution, general features, chemical composition, etc. 3600 w. Sch of Mines Qr—April, 1901. Serial. 1st part. No. 41671 D.

Timber.

Composite Timber Columns. Halbert Powers Gillette. Gives deductions which seem to indicate that under certain conditions composite columns may be considered as acting like a single solid stick. 1000 w. Eng News—June 13, 1901. No. 41585.

MEASUREMENT.

Alignement.

The Alignement of the Simplon Tunnel (Ueber die Absteckung des Simplon-Tunnels). Max Rosenmund. An illustrated account of the triangulation over the Simplon pass in connection with the alignement of the tunnel. Two articles, 2500 w. Schweizerische Bauzeitung—May 25, June 8, 1901. No. 41757 each B.

Surveying.

The Errors of Traverse Surveys. William D. Pence. Reviews briefly the limits of error recommended by various engineers and authors of standard text books, and presents a simple rational method of fixing the permissible error of closure of a traverse survey under known conditions of field work. 3000 w. Pro of Purdue Soc of Civ Engng—1900-1901. No. 41673 D.

The Schroder Tacheograph. Illustrated description of an instrument shown at the Paris Exhibition. A combination of the plane table with the triangle of Prætorius. 3000 w. Engng—June 7, 1901. No. 41608 A.

See also Mining and Metallurgy, Mining.

Triangulation.

The Accurate Measurement of Angles With the Engineer's Transit. F. D. Cunningham. Describes the methods used. 700 w. Eng News—May 30, 1901. No. 41308.

MUNICIPAL.

Garbage.

Garbage Cremation at Evanston, Ill. Illustrated description of a furnace used to destroy garbage only. 600 w. Eng Rec—June 8, 1901. No. 41469.

Garbage Disposal in Lafayette, Ind. Severance Burrage. Illustrated description of the crematory building and methods of collection, with a copy of the ordinance under which the collection is carried out. 2600 w. Munic Engng—June, 1901. No. 41398 C.

Havana.

The Proposed Sewerage and Drainage Systems of Havana. Reviews the report submitted by Samuel M. Gray, in June, 1900, and the specifications for the work, on the outlines finally adopted. Ill. 2400 w. Eng Rec—June 22, 1900. No. 41873.

Pavements.

A Proposed Asphalt-Macadam Pavement. S. Whinery. Proposal to mix the asphalt with broken stone, and then spreading and rolling as in laying ordinary asphalt pavements. 1600 w. Eng News—June 6, 1901. No. 41457.

Is the Continuous Repair System the Most Economical for Macadam Roads? Halbert Powers Gillette. A record of macadam resurfacing, with recommendations of treatment that will prove more economical than the usual practice. 1000 w. Eng News—June 6, 1901. No. 41455.

Some New Ideas in Road Construction. Editorial review of papers by Messrs. Gillette and Whinery. 2000 w. Eng News—June 6, 1901. No. 41458.

Tar Macadam as Used in Hamilton, Ontario. Fred. J. Warren. Report from a personal examination. Ill. 1800 w. Munic Engng—June, 1901. No. 41397 C.

Sanitation.

House Drainage. W. C. Tyndale. Illustrated discussion of methods. 5000 w. Jour San Inst—April, 1901. No. 41275 F.

Plumbing in the Broad Exchange Building. Illustrated description of the work in a 20-story office building, where the distribution of the water to different floors requires numerous reducing valves and air chambers. 2000 w. Eng Rec—June 15, 1901. No. 41565.

Sanitary Appliances. W. C. Tyndale. Illustrated discussion of the fittings used in the house mainly. 4300 w. Jour San Inst—April, 1901. No. 41274 F.

Septic Tanks.

Experiments on Septic Tank Action at Cornell University. R. B. Williams, Jr. Illustrates and describes the experimental plant for the study of the effects of the various rest periods. 1200 w. Eng News —June 13, 1901. No. 41582.

Sewers.

A Combined Syphon and Overflow. Illustrated description of a short syphon making separate provision for storm water and sewage and having one of the entrance chambers designed to serve as an oveflow outlet. 600 w. Eng Rec—June 8, 1901. No. 41467.

The Sewer System of Lake Bluff, Ill. W. T. Griffith. Illustrated description of a combined system of sanitary and storm water sewerage. 1700 w. Eng News—June 6, 1901. No. 41459.

Valuation.

The Appraisal of Plants for Public Services. Nicholas S. Hill, Jr. A review of the principles on which a property is valued when purchased by private parties or by municipalities. 4000 w. Eng Rec—June 8, 1901. No. 41466.

WATER SUPPLY.

Aqueducts.

The Weston Aqueduct of the Metropolitan Water Works for Boston and Vicinity. Details of the structure are given and information concerning the work. 500 w. Eng News—May 16, 1901. No. 40947.

Artesian Wells.

Artesian Water Supply in Australia. W. Gibbons Cox. Gives statistics and particulars of the progress of artesian boring and supplies in Queensland, and related information. 3500 w. Engr, Lond—June 21, 1901. No. 41926 A.

Chicago.

The Water Supply System of Chicago. F. B. Embree. Brief historical review, with illustrations. 1600 w. Sci Am—June 29, 1901. No. 41862.

Cincinnati Intake.

The Break in the Intake Caisson for the New Water-Works for Cincinnati, Ohio. Drawing, with explanation of the cause of the accident as given by Mr. G. Bouscaren, the chief engineer. 700 w. Eng News—May 30, 1901. No. 41303.

Constantinople.

The Water Supply of Constantinople (Die Wasserversorgung von Konstantinopel). H. Gruner. A description of the modern supply of the city, and its recent improvement. 2000 w. Gesundheits-Ingenieur—April 30, 1901. No. 41761 B.

Consumption.

Some Observations on the Household Consumption of Water. Henry C. Hodgkins. Describes the service and gives readings of water meter taken at varying intervals under a variety of conditions. 1800 w. Am Water Wks Assn—June, 1901. No. 41933 C.

Dams.

See Civil Engineering, Canals, Rivers, and Harbors.

Dam Failures.

Accidents to Reservoir Dams. C. Baillarge. Describes the washouts at the reservoir dam at Middlefield, Mass., and that at Chicoutimi, Que. 1600 w. Can Archt—June, 1901. No. 41968 C.

Electrolysis.

An Electrolysis Survey at Columbus, Ohio. Statement of investigations to determine the electric current carried by water-mains, and the suggestions of F. C. Caldwell for avoiding electrolysis of mains. 1300 w. Eng Rec—June 8, 1901. No. 41465.

Elmira, N. Y.

The Elmira Water-Works. J. M. Diven. Illustrated historical account of the works. 2000 w. Fire & Water—June 15, 1901. No. 41639.

Filtration.

Aerator for Mechanical Filter Plant at Winchester, Ky. Leonard Metcalf. Illustrated description. 500 w. Eng News —June 6, 1901. No. 41453.

Six Years of Slow Sand Water Filtration at Mount Vernon, N. Y. Gives a summary of records kept, and details of operation of this plan, which is modeled closely after the one at Lawrence, Mass., and put in operation less than a year after its model. Also editorial giving comparative figures. 4100 w. Eng News—May 30, 1901. No. 41306.

The Filter Galleries at Painesville, Ohio. Illustrated description of galleries built close to the low-water line of Lake Erie, so that wave action on the sand keeps the latter from clogging. 500 w. Eng Rec—June 1, 1901. No. 41340.

Gibraltar.

The Water Supply of Gibraltar. William P. Mason. An illustrated account of the sources of water supply, the storage system, etc. 1100 w. Eng News—June 27, 1901. No. 41883.

New York.

The Croton Dam and Watershed. Describes the distribution system of Manhattan, giving views of the principal works of interest. 6700 w. Fire & Water—June 15, 1901. No. 41638.

Pumping.

Metropolitan Water Works Pumping Machinery. Will J. Sando. Illustrations, data, cost of operating, etc., of the present equipment. 1700 w. Jour N. E. Water Wks Assn—June, 1901. No. 41380 F.

New Pumping Plant of the Pennichuck Water-Works, Nashua, N. H. Illustrated description of a very heavy 6,000,000-gal. pump driven from a turbine making 400 revolutions per minute. 1600 w. Eng Rec —June 8, 1901. No. 41463.

The New Pumping Plant of the Pennichuck Water-Works, Nashua, N. H. F. W. Dean. States the conditions and the objects to be accomplished, with illustrated description of the plant. 1700 w. Eng News—June 6, 1901. No. 41454.

Purification.

Purification of the Chemung River at Elmira, N. Y. James M. Caird. Describes the system of filtration of the Elmira Water Company. 1500 w. Am Water Wks Assn—June, 1901. No. 41936 C.

The Purification of Water. P. A. Maignen. A review of the whole subject as it appeared a half century ago, and as it appears at present. 4000 w. Am Water Wks Assn—June, 1901. No. 41903 C.

Reservoirs.

Jerome Park Reservoir. Illustrated description of this very important wok. 2000 w. Sci Am—June 1, 1901. No. 41287.

The New Water Works Reservoir at Trenton, N. J. Charles A. Hague. Illustrates and describes a reservoir having a capacity of 110,000.000 gallons, and gives a report of its use since Sept., 1899. 2300 w. Eng News—June 13, 1901. No. 41584.

St. Louis, Mo.

St. Louis Water Works—Distribution System from 1886-1901. B. C. Adkins. Describes the growth of the system, and its maintenance. Ill. 1200 w. Fire & Water—June 15, 1901. No. 41637.

Storage.

Storage Water Supplies. L. J. LeConte. On the importance of the greater relative value of run-off records, as compared with the annual rainfall records, in calculating the catchment water from any given watershed. 700 w. Am Water Wks Assn—June, 1901. No. 41952 C.

Valuation.

The Valuation of the Works of the Contra Costa Water Company. Review of a decision by a California court, in which the property of a company without an exclusive franchise and without power to fix its own charges for water, is valued at about 2½ times its cost of construction. 800 w. Eng Rec—June 1, 1901. No. 41338.

Waste.

The Restrictive features to Guard Against Waste Water. S. J. Rosamond On the value of self-closing fixtures where meters are not in use. 1200 w. Am Water Wks Assn—June, 1901. No. 41935 C.

Water Diversion.

Proposed Compensation in Kind for Water Diverted for the Supply of Norwich, Conn. Hill, Quick & Allen. Outlines a plan for compensating mill-owners for diverted water by supplying them with stored water in times of drouth. 2000 w. Eng News—May 23, 1901. No. 41207.

Water Economy.

An attempt to Prove That Thrift in the Operation of Water Works Is More Economical Than Waste. Clemens Herschel. Urging the selling water for domestic uses by measure, and giving information bearing on this subject. 4500 w. Am Water Wks Assn—June, 1901. No. 41934 C.

Water Ram.

Water Ram Utilized. G. T. Lotta. Describes the writer's method of utilizing the water ram to elevate water to a barn on a large stock farm located on very high ground. 400 w. Am Water Wks Assn—June, 1901. No. 41931 C.

Water Sanitation.

On the Rise and Progress of Water-Supply Sanitation in the Nineteenth Century. William T. Sedgwick. Discusses the advancement made, the past troubles of lead poisoning, impure water as a cause of disease, opinions of experts, various supplies, etc. 1000 w. Jour N. E. Water Wks Assn—June, 1901. No. 41381 F.

MISCELLANY.

Business Relationship.

Clients, Engineers, and Contractors. An editorial discussion of the legal rights in the business relations, and the extent of the engineer's authority. 3000 w. Engng —April 19, 1901. No. 40645 A.

Contracts.

American Contractors and British Contracts. Editorial on Sir Alfred Hickman's remarks in the House of Commons regarding the American railway contracts for India, and Lord George Hamilton's reply. 2500 w. Engng—June 7, 1901. No. 41610 A.

Engineers' Fees.

The New Schedule of Fees of German Architects and Engineers. Translation of the schedule adopted by most of the leading German architectural and engineering associations. The first installment gives the principles on which the schedule is based and the directions for computing architects' fees. 2200 w. Eng Rec—May 18, 1901. Serial. 1st part. No. 40965.

Rainfall.

The Causes of Rainfall. Prof. W. M. Davis. An explanation of the causes, and reasons for believing the artificial production of rain impossible. General discussion. 6300 w. Jour N. E. Water Wks Assn—June, 1901. No. 41382 F.

ECONOMICS AND INDUSTRY

ECONOMICS AND INDUSTRY.

Association.

Constitution of the National Metal Trades' Association. A copy of the revised constitution as amended at the N. Y. meeting. 4400 w. Ir Trd Rev—June 20, 1901. No. 41690.

Export Traffic.

The Dangers of the St. Lawrence Route for Export Traffic. Extracts from an article in the *N. Y. Tribune* setting forth the dangers to navigation and needed improvements, with editorial comment. 2300 w. Eng News—May 16, 1901. No. 40946.

Japan.

Japan, Our Latest and Greatest Rival for Commercial Supremacy in the Far East. Alexander Hume Ford. The present aticle considers the recent transition in Japan, her importance as a nation, her progress in the world's trade, and matters of related interest. 2800 w. Ir Age—May 2, 1901. No. 40658.

Labor.

The Relations of Capital and Labor. Herman Justi. An address delivered under the auspices of the Federation of Labor on Labor Day, at Springfield, Ill. 2300 w. Mines & Min—June, 1901. No. 41476 C.

Money Metals.

An Inquiry Into the Money Metals. Abstracted from reports by William Jacobs. Concerning the consumption of the precious metals in the world before the reign of the Emperor Augustus of Rome. 2000 w. Min Rept—May 30, 1901. Serial. 1st part. No. 41330.

Rival Ports.

Genoa and Marseilles. An explanation of the relative position of these two shipping centers. 1800 w. Engr, Lond—April 19, 1901. No. 40653 A.

Russia.

Russia as a Market for Machinery and Machine Tools. A. H. Ford. A review of present condition of the machinery trade in Russia, with especial reference to the disadvantageous position of the United States. 3000 w. Engineering Magazine—July, 1901. No. 41772 B.

Steel Trade.

President Schawb Before the Industrial Commission. An interesting report of testimony given. 9800 w. Ir Age—May 16, 1901. No. 40914.

The Federal Industrial Commission. Reports the testimony of three prominent men in the iron and steel business, chosen as representatives of the independent interests. 8200 w. Ir Age—May 23, 1901. No. 41053.

Strikes.

Strikes Ancient and Modern. Albert Stritmatter. Reviews early strikes in the United States, and gives table showing the increase. 1700 w. Am Mfr—June 6, 1901. No. 41542.

The Dayton Strike. An account of the troubles at the works of the National Cash Register Company. 2300 w. Ir Age—May 30, 1901. No. 41422.

The Machinists' Strike. A statement of the changed conditions, with editorial. 12600 w. Ir Age—June 6, 1901. No. 41424.

The Machinists' Strike in the United States. An editorial commentary upon the situation based upon the opinions of a number of leading employers. 2000 w. Engineering Magazine—July, 1901. No. 41779 B.

The Machinists' Strike. Reports from all sections of the country. 10500 w. Ir Age—May 30, 1901. No. 41423.

Trusts.

How Trusts Affect Prices. Jeremiah W. Jenks. A study of the results of combination on the distribution of wealth; the savings effected, and who receives the benefit. 4800 w. N Am Rev—June, 1901. No. 41332 D.

Wages.

The Economic Status of Wages. Edward Howell Putnam. A discussion of this subject, especially as applied to foundry work. 5400 w. Jour Am Found Assn—June, 1901. No. 41323.

ELECTRICAL ENGINEERING

COMMUNICATION.

Alternating Currents.

The Application of Alternating Currents to Cable Telegraphy (Darf Man die Theorie Rein Sinusformiger Wechselströme in Fragen der Kabeltelegraphic Anwenden?). Dr. F. Breisig. A comparison of the electrical transmission of power, with the possibility of telegraphing with similar currents. 4500 w. Elektrotech Zeitschr—May 16, 1901. No. 4174[illegible] B.

Berliner Patent.

The Berliner Telephone Patent Decision. The full text of Judge Brown's decision, with illustrations. 40000 w. Elec Wld & Eng—June 29, 1901. No. 41901.

Cables.

A Graphic Method for Calculating the Distance of a Break in a Submarine Cable. E. Jona. An explanation of method with a table of values to save calculation. 1200 w. Electric, Lond—June 21, 1901. No. 41903 A.

Localization of High Resistance Breaks. J. Rymer-Jones. An explanation of a test devised by the writer. 3200 w. Elec Rev, Lond—June 7, 1901. Serial. 1st part. No. 41628 A.

Improvements.

The Latest Triumphs of Electrical Invention. Joseph S. Ames. Discusses the recent work of Marconi, Tesla and Pupin. 3700 w. Am Rev of Revs—June, 1901. No. 41335 C.

Phonograph.

See Electrical Engineering, Electrochemistry.

Printing Telegraph.

A New Page-Printing Telegraph. Discussion of paper by William B. Vansize. 8700 w. Trans Am Inst of Elec Engrs—May, 1901. No. 41605 D.

Space Telegraphy.

Experiments in Wireless Telegraphy with the Guarini Automatic Repeater. Gives the report laid before the Paris Congress, Sept., 1900, in regard to land communication, and then a summary of recent results of experiments by M. Guarini, between populous towns. 1500 w. Elec Rev, Lond—May 24, 1901. Serial. 1st part. No. 41353 A.

Variable Transmitters for Wireless Telegraphy (Ueber Einige Sendervariauten für Drahtlose Telegraphie). Dr. F. Braun. Discussing the various methods of turning transmitter and receivers to obtain varied syntonism. 1500 w. Elektrotech Zeitschr—June 6, 1901. No. 41752 B.

Wireless Telegraphy. Reginald A. Fessenden. Compares some of the results obtained by the U. S. Weather Bureau, with those of Marconi, noting where they go along parallel lines, differences in methods and results as published, and also work not known to have been duplicated. 2600 w. Elec Wld & Engr—June 29, 1901. No. 41899.

Telegraphy.

The Application of Storage Batteries to Railway Telegraph Service. W. E. Athearn. Extracts from a paper read before the Ry Tel Supts' Assn. Points drawing the economy of such installations and the care needed. 1200 w. Elec Rev, N. Y—July 6, 1901. No. 42017.

The Importance in Telegraphy of Apparently Little Things. Thomas D. Lockwood. Extracts from a paper read before the Ry Tel Supts' Assn. Considers points relating to the conductor and instruments and also the batteries. 1800 w. Elec Rev, N. Y—July 6, 1901. No. 42015.

Telegraphone.

The Telegraphone. An illustrated description of the remarkable recording telephone invented by Herr Poulsen. 1500 w. Nature—June 20, 1901. No. 41909 A.

Telephone Exchange.

Scranton's New Independent Telephone Exchange. Kempster B. Miller. Illustrated detailed description of the new independent telephone exchange. 3000 w. Elec Wld & Engr—June 8, 1901. No. 41549.

Telephony.

A Comparison of the Bell and Independent Systems and Methods of Operation. R. Max Eaton. Discusses the methods of both companies and the telephone problem generally. 1700 w. Elec, N. Y.—June 19, 1901. No. 41687.

A European Study of American Telephone Statistics. G. De La Touanne. A discussion of the statistics of the American Bell Telephone Co. 1900 w. Elec Wld & Engr—June 8, 1901. No. 41544.

Batteries Used in Telephony. P. Kerr Higgins. The present article treats of the primary battery, and the requirements of a good primary cell, descibing several forms. Ill. 3000 w. Elec, N. Y.—June 12, 1901. No. 41573.

Note on a Humming Telephone. F. Gill. A record of experiments showing the behavior of the humming telephone. 2000 w. Elec Rev, Lond—May 31, 1901. No. 41490 A.

Judge Thomas on Independent Telephony. His views on the growth and strength of the independent movement. 3500 w. Elec Wld & Engr—June 8, 1901. No. 41550.

Rights of Abutting Owners as Against Telephone and Telegraph Companies. G. C. Hamilton. From the *Central Law Journal*. Discusses some of the questions that have been raised and the opinions rendered. 2500 w. Elec Rev, N. Y.—May 4, 1901. No. 40772.

Telephone Exchange Service. L. W. Stanton. Read before the Ind. Telephone Con. Discusses the importance of good apparatus in securing reliability, promptness and good transmission. 2500 w. Elec Rev, N. Y—July 6, 1901. No. 41018.

The Telephone in Railroad Service. F. P. Valentine. Read before the Assn of Ry. Tel. Supts. Discusses the advantage of the use of the telephone in this work and how to obtain the best results. 3200 w. R R Gaz—July 5, 1901. No. 42965.

Village Exchanges and Farmers' Lines. S. P. Sheerin. Read at Buffalo meeting of Ind. Tel. Assn. Considers some points in connection with country lines. 3300 w. Elec, N. Y—July 3, 1901. No. 41954.

Writing Telegraph.

The Electrograph—A New Facsimile Telegraph. Illustrates and describes an instrument on exhibition at the Pan-American, in the U. S. Patent Office exhibit, which is a decided advance on other facsimile telegraphs. 1500 w. Sci Am—June 15, 1901. No. 41587.

The Telautograph. Illustrative description of the Foster Ritchie writing telegraph, and its operation. 1400 w. Nature—May 30, 1901. No. 41482 A.

DISTRIBUTION.

Computation.

The Application of the Cord Polygon to the Computation of Current Distribution (Die Anwendung des Seilecks für die Berechung der Stromveltheilung). Ph. Pforr. An application of the methods of graphical statics to electrical current distribution for tramways. 4000 w. Elektrotech Zeitschr—May 16, 1901. No. 41741 B.

Controller.

Improved Controller for Polphase Currents (Neue Drehstrom Kontroller). W. Ephraim. Diagrams and views of the controller of the "Helios" Company, for use with polyphase motors. 1200 w. Elektrotech Zeitschr—June 6, 1901. No. 41-750 B.

Currents.

Capacity Currents as Influenced by Frequency. T. Mather. Gives results of experiments made on the influence of frequency on capacity currents supplied by a machine having a somewhat peaked E. M. F. wave, showing the wave forms of current and P. D. actually obtained. 1700 w. Elec Rev, Lond—May 31, 1901. No. 41-486 A.

Pressure.

Pressure of Supply. Arthur C. F. Webb. Comparisons between the rapidly disappearing 100-volt pressure and the more modern 200 to 230 volts pressure. 1700 w. Aust Min Stand—May 2, 1901. No. 41-523 B.

ELECTRO-CHEMISTRY.

Accumulators.

See Electrical Engineering, Generating Stations.

See Mechanical Engineering, Automobilism.

Acetylene.

The Electrochemical Behavior of Acetylene (Ueber das Elektrochemische Verhalten des Acetylens). Dr. H. von Steinwehr. A discussion of the possibilities of acetylene in organic synthesis. 1200 w. Zeitschr f Elektrochemie—June 6, 1901. No. 41754 G.

Address.

Electro-Chemical Industries. A. H. Jackson. Abstract of a lecture delivered before the Victorian Society of Chemical Industry. 1900 w. Aust Min Stand—May 2, 1901. Serial. 1st part. No. 41524 B.

Bleaching.

Bleaching by Electricity. George E. Walsh. Briefly reviews the methods, showing the advancement made. 1000 w. Elec Rev, N. Y.—June 15, 1901. No. 41657.

Diaphragms.

Concerning Diaphragms (Ueber Diaphragmen). Dr. M. Le Blanc. A paper before the German Electrochemical Society discussing the action of various kinds of diaphragms used in connection with electrolytic work. 3500 w. Zeitschr f Electrochemie—May 30, 1901. No. 41-753 G.

"Dry Cells."

Experiments with Commercial "Dry Cells," for Secondary Standards of E. M. F. Henry St. John Hyde. An account of experiments made in the Physical Laboratory of Columbia Univ. in order to ascertain the constancy of the E. M. F. under varying conditions. 2500 w. Sch of Mines Qr—April, 1901. No. 41672 D.

Laboratory.

The Electrochemical Laboratory at Owens College. R. S. Hutton. Illustrates and describes the new Physical Laboratories of the Owens College, Manchester, Eng., which are equipped for electrochemical and especial electrometallurgical work. 1800 w. Elec Chem & Met—May, 1901. No. 41484 A.

Mercury Process.

The Mercury Processes for the Production of Caustic Alkalies and Chlorine. John B. C. Kershaw. Gives details concerning the present position of the non-diaphragm mercury processes. Ill. 1300 w. Elec,N. Y.—June 5, 1901. No. 41400.

Phonograph.

A New Phonographic Principle. W. Nernst and R. von Lieben. From the *Zeitschrift für Electrochemie.* Explains the principle of a new phonograph, in which the electrochemical action of a current upon an endless platinum band enables variations of current to be reproduced in a microphone. 3500 w. Elect'n, Lond—June 7, 1901. No. 41635 A.

ELECTRO-PHYSICS.

Condensers.

Some Notes on Dielectric Losses. Charles Proteus Steinmetz. Gives results of some determinations of the loss of power in electrostatic condensers on an alternating-current circuit, and at various frequencies and voltages. 800 w. Elec Wld & Engr—June 22, 1901. No. 41868.

The Influence of a Non-Inductive Resistance on the Oscillatory Discharge of a Condenser. T. Mizuno. Mathematical demonstration. 600 w. Elect'n, Lond—May 24, 1901. No. 41357 A.

Hysteresis.

Distribution of Hysteresis in a Plate of Sheet Iron (Verlauf des Hysteresiskoëfficienten innerhalb einer Blechtafel). Dr. G. Stern. Detail of measurements at various places in a piece of sheet iron are given, showing the variations. 2000 w. Elektrotech Zeitschr—May 23, 1901. No. 41745 B.

Nickel.

Note on Nickel at High Temperatures. Albert Campbell. Gives results of some experiments in connection with a hot wire current regulator. 300 w. Elec Rev, Lond—June 14, 1901. No. 41825 A.

Permeability.

An Instrument for Measuring the Permeability of Iron and Steel. C. G. Lamb and Miles Walker. Read before the Inst. of Elec. Engrs. Illustrates and describes an instrument designed to meet the demand for a simple, cheap and reliable piece of apparatus for this use. 3700 w. Elect'n, Lond—June 7, 1901. No. 41636 A.

Radiography.

New Process of Pelvimetry and Long Distance Radiography. From *La Nature*. An illustrated account of investigations made by Dr. Varnier, the results of which promise to be of value to physicians. 900 w. Sci Am Sup—May 11, 1901. No. 40900.

On Anode Rays. W. Hibbert. Observations noted during a series of experiments on the absorption of X rays by various salts and metals. Ill. 900 w. Elec Rev, Lond—June 7, 1901. No. 41629 A.

Wave Photography.

Photography of Alternating-Current Waves by the Braun Tube (Demonstration und Photographie von Wechselstromkurven mittels der Braunischen Rohre). A. Weinhold. With reproductions of photographs of monophase, biphase, and triphase waves. 2500 w. Elektrotech Zeitschr—May 16, 1901. No. 41740 B.

GENERATING STATIONS.

Accumulators.

A general Study of the Storage Battery as a Load Equalizer (Die Pufferbatterie im Allgemeinen). O. Hoppe. An examination of the advantages of the storage battery as an equalizer of the load, with reference to the power plant at Thiede, near Brunswick. 6000 w. 1 plate. Glückauf—June 1, 1901. No. 41733 B.

Installation, Operation and Economy of Storage Batteries. Ernest Lunn. Considers the battery plant of the Edison Illuminating Co., of Detroit, Mich., giving also a description of the cell most commonly used in lighting and power stations. Ill. 5000 w. Jour Assn of Engng Socs—April, 1901. No. 41291 C.

Storage Batteries in Electric Power Stations, Controlled by Reversible Boosters. J. S. Highfield. Read before the Inst. of Elec. Engrs., England. Discusses what seems to be the chief points in considering the designing of batteries for the work in central stations, and describes the subsidiary apparatus which may be found of use and convenience in operating batteries. 4000 w. Elec Rev, Lond—June 14, 1901. Serial. 1st part. No. 41826 A.

The Storage of Electricity. A. H. Allen. Read before the Civ. & Mech. Engrs. Soc. Considers the application of storage batteries to complete storage, partial storage, and fly-wheel storage. Ill. 3300 w. Engr, Lond—May 31, 1901. Serial. 1st part. No. 41498 A.

Alternators.

The Influence of Circumferential Velocity Upon the Dimensions and Weight of Alternators (Ueber den Einfluss der Umfangsgeschwindigkeit auf die Dimensionen und Materialgeuricht von Drehstromgeneratoren). A. Siewert. With computations of weights and dimensions in comparative cases. 3000 w. Elektrotech Zeitschr—June 6, 1901. No. 41749 B.

Armatures.

The Resistance of Short-Circuited Armatures (Der Wilderstand des Kurzschlussankers). J. Heubach. Deriving formulas for the computation of the resistance, with diagrams showing the relations of the line curves. 3000 w. Elektrotech Zeitschr—May 23, 1901. No. 41744 B.

The Winding of Closed Coil Drum Armatures. William Beckit Burnie. Explains how it is possible to get all the formulæ commonly used for driven armatures from one single expression. 2300 w. Elect'n, Lond—May 31, 1901. No. 41480 A.

Central Stations.

The Central Station Boiler Room. William D. Ennis. A discussion of points essential to the securing of economical and satisfactory results. 3000 w. Am Elect'n—July, 1901. No. 41971.

Converters.

Starting Rotary Converters. Arthur B. Weeks. Gives directions for starting, and notes on other points relating to rotaries. Ill. 2400 w. Am Elect'n—July, 1901. No. 41975.

Chaudiere Falls.

Chaudiere Falls Power Transmission Plant. R. Girouard. An illustrated account of the hydraulic development, transmission line, power house and sub-stations. 1200 w. Elec Wld & Engr—June 15, 1901. No. 41664.

Dynamos.

Faults in Dynamos. Lamar Lyndon.

Discusses the chief irregularities to which dynamos are subject and their causes and remedies. 2500 w. Marine Engng—July, 1901. Serial, 1st part. No. 42013 C.

Magnetic Attraction in Dynamos Due to the Armature and Field being Non-concentric. Edgar Knowlton. Gives a fairly accurate method of calculating the magnetic attraction for a specified displacement. Mathematical. 1200 w. Elec Wld & Engr—June 8, 1901. No. 41547.

Energy Diagrams.

Energy Diagrams of Small Electric Lighting Plants. Illustrated description of a graphical method of indicating the transformation of energy in two small stations. 800 w. Eng Rec—June 15, 1901. No. 41561.

Fuel-Gas Plant.

A Fuel Gas Plant for a Model Isolated Hospital in England. Illustrated description of the plant for six hospital buildings at Shingford. 1300 w. Elec Wld & Engr—June 1, 1901. No. 41405.

Generating Set.

Generating Set of 830 Kilowatts (Groupe Electrogène de 830 Kilowatts). The group, exhibited at Paris, consisted of a 1200 h. p. compound Corliss engine by Crépelle & Garand, of Lille, and two dynamos of 415 kw. each, one on each side of the fly wheel. 1000 w. Génie Civil—June 8, 1901. No. 41706 D.

Glasgow Exhibition.

Steam Electric Generating Plant at the Glasgow Exhibition. Review of the exhibit of boilers, engines and electric generators. 3700 w. Engng—June 14, 1901. Serial. 1st part. No. 41834 A.

Ilford, Eng.

Ilford Electricity Works. Illustrated detailed description. 3300 w. Elec Engr, Lond—May 24, 1901. No. 41356 A.

Isolated Plant.

An Isolated Plant at Nassau, Bahama Islands. An illustrated description of the power house and equipment which provides two hotels with light, power, steam and ice. 2300 w. Elec Wld & Engr—June 1, 1901. No. 41403.

Joint Works.

The Kensington and the Notting Hill Companies' Joint Electricity Works. An account of joint generating works erected at a cost of £100,000. Ill. 2800 w. Elec Rev, Lond—June 21, 1901. Serial, 1st part. No. 41912 A.

Lachine Rapids.

The Lachine Rapids Power Plant. An illustrated description of the works, construction of the dams, weirs, gates, turbines, and power houses; also, the switchboard equipment. 6800 w. Can Engr—June, 1901. No. 41570.

Madrid.

The Reconstruction of the Electric Station at Madrid Spain (Umbau des Elektricitäts werkes der Electricity Supply Co. for Spain, Ltd., Madrid). H. Baswitz. An illustrated description of the new plant, giving details of generators, transformers, and distribution. 3000 w. Elektrotech Zeitschr—May 23, 1901. No. 41743 B.

Manchester, N. H.

Electrical Development at Manchester, N. H. Illustrated detailed description of the novel condition made possible by the consolidation of electrical supply interests, by which a single sub-station receives electrical energy from five generating plants and distributes it in four different towns. 4500 w. Elec Wld & Engr—May 25, 1901. No. 41283.

Mountain Stations.

Electric Plants in the Mountains. Describes plants whose design depended on the facilities for transporting the parts to the site of the stations; burros, rope-ways and wagon roads furnishing the basis of classification of the different designs. 2200 w. Eng Rec—June 15, 1901. No. 41560.

Newcastle-on-Tyne.

A Water Power Railway Plant with Electric Power Supply at Newcastle-on-Tyne. An illustrated detailed account of this undertaking for supplying electric power "in bulk." 5000 w. Elect'n, Lond—June 21, 1901. Serial, 1st part. No. 41902 A.

The Beginning of Electric Power Distribution. An illustrated description of the first three-phone electric power supply system in Great Britain. The inauguration of the station at Neptune Bank in Wallsend. 4300 w. Lightning—June 20, 1901. No. 41908 A.

Niagara.

How Niagara Has Been "Harnessed." William C. Andrews. Considers the production of the electricity at the generator and its transmission to Buffalo. 2700 w. Am Rev of Revs—June, 1901. No. 41-334 C.

Pan-American.

Niagara Falls Power Development and the Pan-American Expositon. Orrin E. Dunlap. An illustrated detailed description of features of the power plant, and the transmission of the power for exposition use. 4600 w. W. Elect'n—May 18, 1901. No. 41033.

Polyphase Plant.

On Polyphase Generating and Sub-Station Plant for Electric Traction. A. C. Eborall. Discusses points in a recent paper by H. M. Hobart. 2300 w. Elec Rev, Lond—June 1, 1901. Serial. 1st part. No. 41630 A.

Railway Plant.

Alternating-Current Transmission. Illustrated description of the transmission plant and sub-stations of the Kalamazoo Valley Electric Company. 1400 w. Am Elect'n —July, 1901. No. 41970.

The Electric Installations of the Western Railway of France (Les Installations de la Compagnie des Chemins de Fer de l'Ouest). E. Cappeau. A description of the plant for lighting, miscellaneous power, and for the traction on the Paris-Versailles line. Serial. Part I. 2500 w. Revue Technique—May 10, 1901. No. 41709 D.

Rotherham.

Rotherham Electricity Works. An illustrated description of English works, recently inaugurated. 3000 w. Elec Engr, Lond—May 31, 1901. No. 41491 A.

Steamship Plant.

Electric Light and Power Installation on Steamer "Deutschland." Illustrated detailed description of this very fine plant. 1700 w. Elec Wld & Engr—June 1, 1901. No. 41402.

Traction Plant.

Choice of Type and Periodicity for Electric Traction Plant. H. M. Hobart. Thinks the rotary converter should be superseded by the motor generator, and the periodicity should be still further lowered for the case of very slow speed steam engines; but it may be advantageous to employ rotary converters, and at 25 cycles per second, for plants where the generators are direct connected to high-speed engines. 1100 w. Elec Rev, Lond—May 24, 1901. No. 41354 A.

Transformers.

Testing Large Transformers. John S. Peck. Describes the transformers recently installed by the Cataract Power and Conduit Co., of Buffalo, N. Y., and the methods of testing them. Ill. 2500 w. Elec Wld & Engr—June 22, 1901. No. 41871.

Tynemouth.

Tynemouth Electricity Works. Illustrated detailed description of a plant for electric light and traction at an English health resort. 2700 w. Elec Engr, Lond —June 7, 1901. No. 41631 A.

Wigan.

Wigan Corporation Electric Supply and Tramway Works. Illustrated detailed description. 1500 w. Elect'n Lond—June 7, 1901. No. 41632 A.

LIGHTING.

Arc Lighting.

Arc Lighting at the Beginning of the Twentieth Century. H. W. Hillman. Read before the Nat. Elec. Lgt. Assn. Discusses the reasons for adopting the alternating system of street lighting at Atlanta, and the subject generally; the operation, cost and methods. Ill. 3700 w. Elec Rev, N. Y—June 8, 1901. No. 41552.

Arcs.

The Behaviour of Continuous Current Arcs (Neue Wirkungen des Gleichstromlichtbogens). W. Penkert. With especial reference to the musical arcs of Simon and of Duddell, giving computations of the periods of vibration. 2500 w. Elektrotech Zeitschr—June 6, 1901. No. 41-751 B.

Dimming.

A Cheap Method of Dimming Lamps (Eine Billige Methode der Lampenverdunkelung). P. Stern. Two lamps are used either in parallel or in series, the latter arrangement being used when diminished illumination is desired. 1200 w. Elektrotech Zeitschr—May 30, 1901. No. 41748 B.

Lamps.

From Cotton-Wool to Candle-Power. Describes a visit to an English glow-lamp factory. Ill. 2400 w. Lightning—May 30, 1901. No. 41483 A.

Pan-American.

Artistic Effects of the Pan-American Exposition. Ernest Knaufft. An illustrated account of the fine effects produced by electric lighting. 3300 w. Am Rev of Revs—June, 1901. No. 41333 C.

Searchlights.

The Modern Searchlight in the Navy. Frank C. Perkins. Illustrated descriptions of some searchlights in use and the methods of operating. 1500 w. Elec, N. Y—June 5, 1901. No. 41401.

Vapor Lamps.

Mr. P. Cooper Hewitt's New Mercury Vapor Lamp. Legh S. Powell. An account of an experiment made, illustrating the apparatus used, during which similar effects were observed as early as 1885. Also an article explaining the theory of this lamp. 2800 w. Elec Rev, Lond—May 24, 1901. No. 41355 A.

MEASUREMENT.

Alternate Currents.

On Test-Room Methods of Alternate-Current Measurement. Albert Campbell. Abstract of a paper read before the Inst. of Elec Engrs., England. Describes a number of methods of measurement, some of which are capable of fairly general application, while others are only of use in special cases. 2000 w. Elect'n, Lond—June 7, 1901. Serial. 1st part. No. 41-634 A.

Electric Balance.

A Sensitive Electrical Balance (Sur une Balance Très Sensible Pouvant Servir de Galvanometre, d'Electrodynamometre et d'Electromètre Absolu). V. Crenneu. Describing a modification of M. Lippmann's astatic galvanometer. 1000 w. Comptes Rendus—May 28, 1901. No. 41-738 D.

Galvanometer.

A Perfectly Astatic Galvanometer (Sur un Galvanometre Parfaitement Astatique). M. Lippman. The needle is so suspended as to be displaced parallel to itself by the action of the current. 1000 w. Comptes Rendus—May 13, 1901. No. 41737 D.

Meter.

A Watt-Hour Meter. Frank Holden. Read before the Inst. of Elec. Engrs. Describes the Frazer meter, showing its defects, and using it for comparison in describing the meter which is the subject of this paper. Ill. 2600 w. Elect'n, Lond—May 24, 1901. Serial. 1st part. No. 41-358 A.

POWER APPLICATIONS.

Coal Handling.

Electric Coal Handling Plant at the Harbor of Rotterdam (Elektrisch Betriebene Kohlenkippe für den Hafen von Rotterdam). A very full account of the harbor improvements at Rotterdam, with illustrations of the plant by which the extensive coal trade is handled. Serial, Part I., 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—June 8, 1901. No. 41-716 D.

Coke Plant.

The Electric Installation at the Orlau-Lazy Coke Ovens (Die Elektrische Anlage in der Koks anstalt Orlau-Lazy). A. Hartmann. With illustrations of the extensive coke handling plant in Austrian Silesia, including electrically driven charging, handling, and washing machinery. 1800 w. Elektrotech Zeitschr—May 30, 1901. No. 41746 B.

Cranes.

See Mechincal Engineering, Machine Works and Foundries.

Diamond Drill.

See Mining and Metallurgy, Mining.

Dry Dock.

The Largest Electrically Operated Dry Dock in the World. An illustrated description of the recently completed electric dry-dock of South Brooklyn, N. Y. 1200 w. Elec Wld & Engr—June 22, 1901. No. 41867.

Ingot Stripper.

An Electric Ingot Stripper. An illustrated description of the machine in use at the Worcester (Mass.) Works of the American Steel and Wire Co., and the method of operating. 2600 w. Ir & Coal Trds Rev—June 7, 1901. No. 41606 A.

Motors.

A Rotary Field Electrostatic Induction Motor. Prof. Hidetaro Ho. The non-mathematical portion of a paper from the *Journal of the Inst. of Elec. Engrs.*, of Tokyo, Japan. Illustrated description. 1600 w. Elec Wld & Engr—June 15, 1901. No. 41665.

Self-Starting Single-Phase Motor Without Brushes. J. Fischer-Hinnen. Illustrated description of a motor where the current distribution in the armature required for starting is effected by means of induction, doing away entirely with the brushes. 800 w. Elec Wld & Engr—June 22, 1901. No. 41869.

The Computation of the Stray Co-efficient in Induction Motors (Ueber die Berechnung des Streuungsfaktors Asynchroner Motoren). J. Jonas. Deriving formulas for the coefficients of the stator and the rotor in terms of the e. m. f. of the respective fields. 3500 w. Elektrotech Zeitschr—May 30, 1901. No. 41747 B.

The Polyphase Induction Motor for General Power Service. Ralph D. Mershon. Presents the merits of the induction motor for general power service and corrects misconceptions which exist concerning it. 2500 w. Elec Wld & Engr—June 8, 1901. No. 41546.

Parallel Driving.

Notes on the Theory of Synchronous Motors and of Alternators in Parallel. Alexander Russell. A sketch of the elements of the mathematical theory of the synchronous motor and of alternators in parallel, illustrating the results by means of curves. 2000 w. Elec Rev, Lond—May 31, 1901. Serial. 1st part. No. 41488 A.

Power Supply.

Power Supply from Alternating Current Stations. Gives a solution of this problem which has been tried and found very successful. 2500 w. Elec Rev, Lond—May 31, 1901. No. 41487 A.

Pumping Plant.

See Mining and Metallurgy, Mining.

Rock Drills.

Practical Trials with Rotary Electric Rock Drills. C. Schraml, in *Oesterreichische Ueitschrift für Berg-und Hüttenwesen.* Report of trials and illustrated description of drills used. 1800 w. Col Guard—June 7, 1901. No. 41616 A.

The Development of Electrically Driven Rock Drills (Ueber die Entwicklung der Gesteinsdrehbohrmaschinen mit Elektrischem Antriebe). C. Schraml. A review of recent progress, with description of the machines of the Union Electric Co., Siemens & Halske, and Bornet. Two articles, 5000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—May 18, 25, 1901. No. 41734 each B.

TRANSMISSION.

High Potential.

The Transmission of Current at High

Potential in New York City. Calvin W. Rice. Read at convention of Nat. Elec. Lgt. Assn. Also editorial. An interesting resumé of high voltage power transmission as practiced in New York, giving practical information underground work in this field. 3500 w. Elec Wld & Engr—May 25, 1901. No. 41282.

Line.

A 4,427-foot Span in an Electric Transmission Line. Illustrates and describes an interesting feature of the line of the Bay Counties Power Company, of San Francisco, whereby high tension electrical energy is carried across navigable tide-water, 200 feet above high-water level. 2700 w. Eng Rec—June 22, 1901. No. 41872.

Spanning Carquinez Straits with a High-Potential Transmission Line. R. H. Sterling. An illustrated description of an aerial crossing at the point named and the method of construction. 1400 w. Elec Wld & Engr—June 8, 1901. No. 41545.

Los Angeles.

Los Angeles Transmission Plants. Deals mainly with the two large plants, giving results of operation. 2000 w. Elec Wld & Engr—June 22, 1901. No. 41870.

MISCELLANY.

Accidents.

Electric Accidents and the Means of Preventing Them. L. W. de Grave. Abstract of a paper read before the Chesterfield & Midland Co.'s Inst. of Engrs. Discusses the causes and considers accidents usually due to gross carelessness. Also measures for protection and prevention. 2200 w. Col Guard—May 31, 1901. No. 41506 A.

Berlin.

The Coming Visit of the Institution of Electrical Engineers to Berlin. A series of brief illustrated descriptions of the works to be visited. The present article gives a sketch of the machine and apparatus works of the Allgemeine Elektricitäts-Gesellschaft. 1400 w. Elec Engr, Lond—April 26, 1901. Serial. 1st part. No. 40801 A.

Lightning.

The Protection of Buildings from Lightning. Alfred Hands. Read before the Architectural Assn., England. Briefly explains the electrical action during a thunderstorm, reviews the history of protection, and discusses the prevailing practice. Also discussion. 12600 w. Builder—May 18, 1901. No. 41238 A.

Rowland.

Henry A. Rowland. Cary T. Hutchinson. On the work done by him in applied electrical science. 2000 w. Elec Wld & Engr—May 4, 1901. No. 40789.

GAS ENGINEERING

Acetylene.

Analysis and Purification of Acetylene. Summary of an address, compiled by Herren A. Rossel and E. Landriset, delivered at the inauguration of the Swiss Carbide and Acetylene Association at Berne. 2500 w. Jour Gas Lgt—June 11, 1901. No. 41692 A.

See Electrical Engineering, Electrochemistry.

Address.

Inaugural Address Before the Incorporated Gas Institute, England. T. Ormiston Paterson. Reviews the difficulties met and conquered by the gas industry in the early part of the 19th century, and discusses the problems of the present. 5500 w. Jour Gas Lgt—June 11, 1901. No. 41691 A.

Benzol.

A New Test for Sulphur in Benzol for Use in Gas Works. Wilfrid Irwin. Read at the May meeting of the Manchester Section of the Soc. of Chem. Ind. Gives the usual methods employed for the determination, and also the author's method. 1100 w. Gas Wld—June 15, 1901. No. 41828 A.

Blast-Furnace Gases.

The Utilization of Blast Furnace Gases. A review of an address by M. J. Deschamps and the discussion that followed. 1400 w. Engr, Lond—June 7, 1901. No. 41614 A.

Electrolysis.

A French Opinion of Electrolysis of Pipes. Review of a report claiming that electrolysis will not occur where the difference in potential between pipes and rails is less than 1 to 1½ volts. 1600 w. Eng Rec—June 1, 1901. No. 41337.

Report of the Master in Chancery on the Peoria Electrolysis Litigation. Extracts from report filed with the U. S. Circuit Court at Chicago, stating that the pipes were being steadily injured by the return currents of the railways operated by the single trolley system. Also editorial on the effect of this report on electric railway investments. 5000 w. Eng Rec—June 15, 1901. No. 41562.

Fuel Gas.

Mond Fuel Gas in Great Britain. Gives the distinguishing features of the Mond process, and a technical description taken from a paper by Mr. H. A. Humphrey. 1400 w. U S Cons Repts, No. 1063—June 15, 1901. No. 41600 D.

The Mond Gas Bill. An account of interesting facts and figures given in evidence before a Select Committee of the House of Commons. 3000 w. Engr, Lond—May 24, 1901. Serial. 1st part. No. 41362 A.

Fuel-Gas Plant.

See Electrical Engineering, Generating Stations.

Galveston Storm.

A Stormy Experience. John Gimper. Read before the Western Gas Assn. An account of the gas company's experience, having four gasholders destroyed, retort house, shop and warehouse, coal shed, governor house, fence wall and superintendent's dwelling. Discussion. 3000 w. Pro Age—June 15, 1901. No. 41555.

Gasholder.

Description of a Gasholder and Tank Erected at the Hull Station of the British Gaslight Company, with Some Practical Suggestions on Construction. Ill. 3600 w. Jour Gas Lgt—June 4, 1901. No. 41596 A.

Difficulties in Constructing a Concrete Gasholder Tank. Describes the method of building a large tank on a side hill in a clay soil which slipped badly. 2000 w. Eng Rec—June 8, 1901. No. 41464.

Gas Industry.

The Progressive Age. J. D. Ashworth. Read before the Inst. of Gas Engrs. The writer takes a rather depressed view, but gives some suggestions worthy of consideration. Discussion. 4000 w. Gas Wld—May 4, 1901. No. 40921 A.

Gas Machine.

Remarkable Behavior of a Naphtha Gas Machine in a Fire. E. P. Reichhelm. An illustrated description and explanation of the machine which withstood a fierce conflagration without exploding. 800 w. Am Mach—June 13, 1901. No. 41575.

Gas Users.

Business Outside the Usual Channel. F. W. Stone. Read before the Ohio Gas Lgt. Assn. Enumerates some of the uses to which gas may be applied. Also general discussion. Ill. 4000 w. Pro Age—May 1, 1901. No. 40700.

Hygienic Effect.

Gas and Hygiene. James Ferrier. Read at meeting of the Western Gas Assn. A discussion of what constitutes hygienic light and heat, and what should be the policy of the gas industry. Also general discussion. 10000 w. Am Gas Lgt Jour—June 10, 1901. No. 41554.

Incandescence.

High and Low Pressure Gas Incandescent Lighting. William Sugg. Read before the Inc. Gas Inst. The paper emphasizes the importance of the velocity of the gas, and illustrates the author's high-pressure apparatus. 3400 w. Gas Wld—June 15, 1901. No. 41831 A.

Self-Intensifying of Gas Pressure by Means of Waste Heat. C. Scott Snell. Discusses the conditions and gives an illustrated description of the author's invention—the Scott-Snell lamp. Also discussion of this paper, with the papers by Messrs. Sugg and Grafton. 14500 w. Gas Wld—June 15, 1901. No. 41833 A.

Some Notes on Incandescent Gas Lighting. Ernest Feardon. Read before the Manchester and Dist. Jun. Gas Assn. Introductory remarks on this means of producing light, with short descriptions of some of the lamps, and statements as to efficiency, cost, etc. 5000 w. Jour Gas Lgt—May 21, 1901. No. 41301 A.

The Effect of Quality and Pressure of Gas on the Efficiency of Incandescent Gas Lighting, Having Regard to Economy. Walter Grafton. Read at Inc. Gas Inst. meeting. Proposal to reduce the illuminating power of gas to 10 candles by adding air to the gas. 4300 w. Gas Wld—June 15, 1901. No. 41832 A.

The Theory of the Incandescent Gas Burner (Theorie des Gasglühlichtes). Franz Bössner. A discussion of the action of oxides of the metals of the earths in connection with the emission of light when heated. An important study of the incandescent mantle. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—May 31, 1901. No. 41720 B.

Japan.

Lights in Japan. An account of the recent development in house and street lighting, with illustrated description of work of Japanese gas-fitters. 1500 w. Am Gas Lgt Jour—May 20, 1901. No. 41028.

Photometer.

A New Table Photometer and Pentone Ten-Candle Lamp. Frank Clowes. On official gas testing in London, with illustrated descriptions of new apparatus, giving results obtained by its use. 4500 w. Gas Wld—June 15, 1901. No. 41829 A.

Purification.

The Purification of Blast-Furnace Gas. F. W. Lürmann, in *Stahl und Eisen*. Illustrated account of the arrangements in use at several large plants in Germany. 1200 w. Col Guard—May 24, 1901. No. 41372 A.

Selling.

Hints on Gas Selling. John Young. Read before the East. Co.'s Gas Mgrs. Assn. Suggestions of value to works managers, with discussion. 5500 w. Gas Wld—April 20, 1901. No. 40629 A.

Societies.

The Question of Amalgamation. J. W.

Helps. Read before the Inst. of Gas Engs. The story of the proposed amalgamation of the Institution of Gas Engineers, with the Gas Institute, with the discussion that followed. 14500 w. Gas Wld—May 4, 1901. No. 40916 A.

Street Lighting.

Common Sense in Street Lighting. Edward B. Ellicott. Read before the League of Ohio Municipalities. Gives some statistics relating to the cost of lighting with gas or gasoline lamps equipped with incandescent mantles, and discusses the subject generally. 2200 w. Pro Age—June 15, 1901. No. 41556.

Water Gas.

I. Why I Adopted Water Gas. William Longford. II. British Water Gas Practice. Robert Porter. Two papers presented at meeting of the Inc. Gas Inst. and discussed together, though most of the interest was in replying to Mr. Porter's paper. Ill. 21500 w. Gas Wld—June 15, 1901. No. 41830 A.

MARINE AND NAVAL ENGINEERING

Air Pumps.

Direct Driven Air Pumps. Illustrates and describes the direct driven air pumps adopted for the engines of the Denver class of U. S. cruisers. 400 w. Marine Engng—July, 1901. No. 42010 C.

Battleship.

Launch of the Battleship "Ohio." An illustrated description of the vessel, with some account of the yards in which it was built. 1800 w. Sci Am—June 8, 1901. No. 41451.

Boat Lowering.

The Welin Boat-Lowering Gear. Illustrated description. 700 w. Engng—June 21, 1901. No. 41925 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Navy.

The Romance of Applied Science in the United Kingdom. Reviews the record of the Inst. of Naval Architects, and the development of the shipbuilding industry. 2700 w. Ir & Coal Trds Rev—June 14, 1901. Serial. 1st part. No. 41843 A.

Bulkheads.

The Unsinkability of Ships (Eine Bemerkung über die Unsinkbarkeit der Seeschiffe). Guido Bocchi. A discussion of the proper location of bulkheads, so that the filling of compartments shall not endanger stability. 1800 w. Schiffbau—June 8, 1901. No. 41724 D.

Coaling Barge.

The Clarke Automatic Coaling and Weighing Barge. Illustrated detailed description of this barge for coaling steamers and its method of work. 3000 w. Ir Age—June 20, 1901. No. 41656.

Coaling Boat.

Ingenious Vessel-Coaling Boat. Full illustrated description of the Clarke automatic coaling and weighing barge. 4000 w. Naut Gaz—July 4, 1901. No. 41999.

Coaling Stations.

The Defence of Coaling Stations. S. Eardley-Wilmot. Arguments favoring the defence against sea attack being given to men with sea experience. 1600 w. Engrs Lond—June 21, 1901. No. 41927 A.

Compass Card.

Another Form of Compass Card. A proposal to embody both the degree system and the point system in one card, with a view to bringing about gradually the adoption of the former. 1200 w. Marine Rev—May 23, 1901. No. 41233.

Coppersmithing.

Coppersmithing, with Special Reference to Marine Practice. William Weigman. Suggestions of methods producing satisfactory results. Ill. 700 w. Marine Engng—June, 1901. No. 41533 C.

Corrosion.

A Simple Method of Preventing Corrosion of Tail Shafts. James M. Thornton. Read before the N. E. Coast Inst. of Engrs. & Shipbuilders. Illustrates the method the writer has adopted, by which tail shafts can be preserved and made to last for years without breaking. 1200 w. Engrs' Gaz—June, 1901. No. 41481 A.

Cruisers.

The New Russian High-Speed Cruisers. Facts concerning the four new cruisers ordered, which follow exactly the lines laid down for the Bogatyr. Elevation, deck plan and cross-section are given. 1700 w. Engng—May 24, 1901. No. 41-369 A.

Drydock.

The New Floating Drydock for the United States Navy. Illustrated detailed description of this steel floating drydock, now nearing completion, to be located at Algiers, La. 1700 w. Sci Am—June 15, 1901. No. 41589.

Education.

Schools of Marine Engineering and Naval Architecture. George Crouse Cook. Illustrated account of the facilities for study at the Engineering College of the Imperial University of Tokyo, Japan. 3200

w. Marine Engng—July, 1901. No. 42012 C.

India.

River Steamers and Inland Navigation in India. Information concerning the improvements made in the river steamers since the days of the pioneer vessels. Ill. 2000 w. Ind & East Engr—May, 1901. Serial. 1st part. No. 41595 B.

Indicators.

The Application of the Steam-Engine Indicator to Rowing. C. M. Allen. Illustrated description of the apparatus used, with analyses of the cards taken, and the results. Ill. 2500 w. Jour Worcester Poly Inst—May, 1901. No. 41068 C.

Large Vessels.

Largest Vessels in the World. Illustrated description of the new vessels building for the oriental service of the Great Northern Railway, which are in measurements a little larger than the "Celtic." 1700 w. Marine Rev—June 20, 1901. No. 41697.

Lighthouse.

See Civil Engineering, Construction.

Liquid Fuel.

On the Use of Liquid Fuel in Sea-Going Merchant Steamers. E. L. Orde. Read before the N. E. Coast Inst. of Engrs. and Shipbuilders, at Sunderland, England, Discusses the possibilities of the fuel and the merits of the different classes of apparatus used. 2800 w. Marine Engng—July, 1901. No. 42007 C.

Marine Engineers.

The Examination of Sea-Going Engineers. Editorial review of the alterations in the new regulations initiated by the British Board of Trade. 1300 w. Engng—May 24, 1901. No. 41370 A.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Merchant Marine.

Address Before the National Association of Manufacturers. Theodore C. Search. Extract referring to the upbuilding of the American merchant marine. 4000 w. Marine Rev—June 6, 1901. No. 41527.

Model Basin.

The United States Experimental Model Basin. Illustrated description of this method of determining the resistance of a ship. 1100 w. Sci Am—June 1, 1901. No. 41286.

Ocean Steamships.

Ocean Steamships Half a Century Ago. The first of a series of articles reviewing the ocean steamships built at and running from the port of New York. 3000 w. Naut Gaz—July 4, 1901. Serial. 1st part, No. 42001.

Paying Ships.

Useful or Earning Capacity of Ships. Theodore Lucas. A discussion of points to be carefully considered to insure the money earning capacity of ships. 2200 w. Naut Gaz—June 6, 1901. No. 41543.

Propellers.

Screw Propellers. McKim Chase. Suggestions for the construction of small screw propellers. Ill. 1500 w. Mach, N. Y—July, 1901. No. 41957.

Schooners.

Description of the Steam Schooners Engaged in the Pacific Coast Trade. D. S. Kimball. Illustrated description of these vessels and their engines, manner of loading, etc. 1400 w. Marine Engng—June, 1901. No. 41532 C.

Searchlights.

See Electrical Engineering, Lighting.

Shipbuilding.

Ship Building in the Nineteenth Century. Brief account of the beautiful collection of models shown at the Glasgow exhibition. 1800 w. Marine Rev—May 30, 1901. No. 41300.

The Mechanical Equipment of the Shipyard. Prof. J. H. Biles. The third paper of the series discusses the general arrangement of the plant and the economic advantages of portable electric and pneumatic tools. 3500 w. Engineering Magazine—July, 1901. No. 41774 B.

Works of the New York Ship Building Co. An illustrated description of the works, power producing appliances, and contracts under way. 10000 w. Marine Rev—June 13, 1901. No. 41597.

Shipping.

The American Shipping Purchase. Editorial discussion of the purchase of the Leyland Line of steamers by J. S. Morgan & Co., and J. P. Morgan & Co., giving the details of the transaction. 1800 w. Engng—May 3, 1901. No. 40847 A.

Smokeless Powder.

The Development of Smokeless Powder in the United States. F. A. Wilcox. A consideration of the methods and means employed in the development of smokeless propulsive explosives for military purposes. 2500 w. Engng—May 31, 1901. Serial. 1st part. No. 41500 A.

Curve of Stability. George Crouse Cork. Explains the practice of Scotch shipbuilders in this problem of ship design. Ill. 2000 w. Marine Rev—June 6, 1901. No. 41526.

Stability.

Stability of Passenger Steamers After Collision at Sea, with Discussion of Means to Prevent Capsizing. M. Bertin. Read before the Paris Congress of Naval Archts. Discusses the different methods of foundering, and the means of securing stability. 2800 w. Marine Engng—June, 1901. No. 41530 C.

The Graphical Determination of the Stability of Ships (Graphische Ermittelung der Stabilität des Schiffes). M. H. Bauer. A study of the method of replacing cumbersome analytical methods by a simple graphical construction. Serial, Part I. 1200 w. Schiffbau—June 8, 1901. No. 41723 D.

Steamboat Race.

A Great Steamboat Race. An account of a race on Lake Erie in which the "City of Erie" beat the "Tashmoo" in a run of nearly 100 miles by only 45 seconds. 2000 w. Marine Rev—June 6, 1901. No. 41525.

Official Reports on Erie-Tashmoo Contest. Data taken on each boat is given. Illustrates the indicator cards taken. 1200 w. Marine Rev—June 13, 1901. No. 41598.

Steamers.

Elegant Excursion Steamer. Illustration with an account of the trial trip of the "Thomas Patten," built for service on New York Bay. 1300 w. Naut Gaz—July 4, 1901. No. 42000.

Side-Wheel Passenger Steamer for Lake Champlain. Brief illustrated description of the Transportation Co.'s steamboat "Vermont." 700 w. Marine Engng—July, 1901. No. 42011 C.

Steamship.

New Coasting Steamer. Illustrated description of a compact and well designed wooden propeller under construction at San Francisco. 1000 w. Naut Gaz—May 30, 1901. No. 41425.

Ocean-Going Steamship "Northwestern," Built on the Great Lakes. Illustration of the vessel and engines, with description. 1300 w. Marine Engng—June, 1901. No. 41528 C.

The Mission Stern-Wheel Steamer "Livingstone." Illustrated description of a steamer for missionary work on Stanley Pool. 600 w. Engr, Lond—May 24, 1901. No. 41365 A.

Steamship Plant.

See Electrical Engineering, Generating Stations.

Submarine.

Launch of the Submarine Torpedo Boat "Fulton." Illustrates the launch of this boat which is to be used by the Holland Company as an experimental vessel. 500 w. Sci Am—June 22, 1901. No. 41693.

Thames Service.

The Thames Steamboat Service. Arnold F. Hills. Reviews the history of the Thames Steamboat Company and the special conditions to which the service is subject; discussing also what remains to be accomplished. General discussion follows. 9000 w. Jour Soc of Arts—May 3, 1901. No. 40842 A.

Tide Indicator.

An Electrical Tide Indicator. Grahame H. Powell. Illustrated description of a device for indicating tide levels in connection with artillery range finding. 600 w. Elec Wld & Engr—May 25, 1901. No. 41284.

Ventilation.

Explanation of a Simple Method of Laying Out Ship Ventilating Cowls. George C. Stanley. Presents a group of six cowls and a simple method of determining their outlines. 1000 w. Marine Engng—June, 1901. No. 41531 C.

The Warming and Ventilation of War Ships (Verwarnung en Ventilatie van Oologsschepen). L. N. Alta. Showing arrangements of heating coils and electrically driven fans. 1500 w. De Ingenieur—April 13, 1901. No. 41767 B.

Vibration.

Pallographic Investigations on the Steamship "Deutschland" (Pallographische Untersuchungen au Bord des Schnelldampfers "Deutschland"). A full review of the tests of the Schlick system of counterbalancing as made on the "Deutschland" in June, 1900. 3 articles, 5000 w. Schiffbau—April 23, May 8, 23, 1901. No. 41721 each D.

Yachts.

"Constitution." W. P. Stephens. Illustrated description of this new Cup defender, and information related. 4500 w. Rudder—June, 1901. No. 41516 C.

Constitution and Her Early Trials. W. P. Stephens. An illustrated account with remarks on the American rules and conditions of yachting. 2000 w. Rudder—July, 1901. No. 41998 C.

Launch of "Independence." An illustrated account of the launch of this Cup defender, built at Boston. 1000 w. Rudder—June, 1901. No. 41518 C.

"Shamrock II." Illustrated description of the appearance, and the editor's opinion of her chances in the coming race. Also an account of this vessel by Goeffrey de Holden-Stone. 4900 w. Rudder—June, 1901. No. 41517 C.

The U. S. S. Mayflower. Illustrated description of a fine private yacht, purchased by the U. S. Government during the Spanish-American war. 450 w. Marine Engng—July, 1901. No. 42008 C.

Trial Trip of Independence. C. D. Mower. An illustrated account of the June 3d trial trip. 2100 w. Rudder—July, 1901. No. 41997 C.

The Racing Yacht "Independence." Illustrates and describes this racing yacht. 1100 w. Sci Am Sup—June 29, 1901. No. 41865.

The Three Cup-Yachts of 1901. Discusses the designs of the "Independence," the "Constitution," and the "Shamrock II.," giving illustrations. 1000 w. Sci Am—June 22, 1901. No. 41694.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

Tables of Comparative Data of Accumulators. The data refers chiefly to the cells exhibited in Paris, or to those which took part in the Automobile Club Competition of 1899. 1200 w. Elec Chem & Met—May, 1901. No. 41485 A.

The Sperry Battery. Brief illustrated description of the battery used on the Waverley vehicles. 900 w. Horseless Age—May 29, 1901. No. 41298.

Fuel Pressure.

Fuel Pressure Air Pumps. Charles F. Schaeffer. Illustrates and describes a pump designed for keeping up the air pressure in the gasoline tank. 700 w. Horseless Age—May 29, 1901. No. 41299.

Gasoline Vehicle.

The Fastest Gasoline Automobile. Illustrates details of the Bolide gasoline racing carriage. 1100 w. Sci Am Sup—June 15, 1901. No. 41590.

Gears.

Transmission Gears of Some European Cars. Abstract from a paper by Herbert Austin before the Cycle Engr.'s Inst., London. Describes and compares the Panhard, the De Dietrich and Recault systems. Ill. 4700 w. Auto Mag—July, 1901. No. 41845 C.

Horse-Power.

The Tractive Horse-Power of Vehicles. W. F. D. Crane. Tables for the calculations and comparisons of the horse-power required are given with explanatory notes. 3300 w. Elec Wld & Engr—June 1, 1901. No. 41406.

Japan.

Automobiles in Japan. An account of the vehicles seen, the facilities for securing supplies, the roads, repairs, etc. 1800 w. Horseless Age—June 12, 1901. No. 41569.

Krieger.

Electric Automobile—Krieger System. Illustrated description of one of the latest types. 600 w. Sci Am—June 8, 1901. No. 41450.

Liverpool Trials.

The Liverpool Motor Wagon Trials. An account of these trials, with illustrations of some of the vehicles, and statement of the points taken into consideration by the judges in making the awards. 3000 w. Engr, Lond—June 7, 1901. No. 41613 A.

The Liverpool Trials of Heavy Motor Vehicles. An account of the trials in progress, the vehicles entered, and tabulated report of the first three days. Ill. 4500 w. Engng—June 7, 1901. No. 41609 A.

Trials of Motor Vehicles for Heavy Traffic. An account of the performances of the thirteen vehicles which took part in the Liverpool trials. Ill. 5000 w. Autocar—June 8, 1901. No. 41626 A.

Lorries.

Competition for Automatic Lorry in Great Britain. Conditions for a self-propelled lorry, or wagon, for military purposes. 800 w. U S Cons Repts, No. 1067—June 20, 1901. No. 41674 D.

The Motor Lorries Which Will Compete in the Liverpool Trials. Illustrates and describes the vehicles which took part in the recent trials. All are steamers coke or oil fired, with the exception of two, which are driven by internal combustion engines, and consume motor spirit. 7400 w. Autocar—June 1, 1901. No. 41479 A.

Motor Vehicle.

A Remarkable Motor Wagon. Illustrated description of a novel wagon, invented in Germany, and tested severely with successful results. It is an attempt to secure ease of running whatever the nature of the road-surface. 1300 w. Engr, Lond—May 31, 1901. No. 41494 A.

Racing.

Motor Car Racing in France. Remarks on the importance French manufacturers attach to speed, and the improvements, with brief report of the races. 2000 w. Engr, Lond—June 7, 1901. No. 41612 A.

The Paris-Bordeaux Race. An account of the Gordon-Bennett cup competition and the open race, with illustrations. 4800 w. Autocar—June 8, 1901. No. 41625 A.

Steam Coach.

The Steam Coach in 1825. Robert I. Clagg. An illustrated account of an early vehicle taken from the *American Mechanics' Magazine* of Dec. 17, 1825. 1700 w. Ir Trd Rev—June 6 ,1901. No.41534.

Test.

Laboratory Test of a Gasoline Automobile. F. A. Lockwood. An account of a test made in the Mech. Laboratory of Sibley College. Describes the vehicle and method of testing. 1500 w. Sib Jour of Engng—June, 1901. No. 41669 C.

Tires.

Automobile Tires. Pardon W. Tillinghast. Discusses the fabric of the tire and means for securing on the wheel. 1200 w. Horseless Age—June 26, 1901. No. 41853.

The Michelin Pneumatic. Abstracts

from articles by M. Michelin, published in the *Auto-Vélo,* on the manufacture and care of pneumatic tires. Ill. 1200 w. Horseless Age—June 26, 1901. No. 41858.

The Tire Question in Light and Heavy Vehicles. Albert L. Clough. Discusses the severe conditions imposed upon tires of heavy vehicles as compared with the light vehicle, and the need of a reliable, durable and moderately expensive tire. 800 w. Horseless Age—June 26, 1901. No. 41857.

Tires. Charles E. Duryea. An account of tests to determine what tire rides easiest, propels easiest and is most durable. 1500 w. Horseless Age—June 26, 1901. No. 41852.

Wheels.

Automobile Wheels. C. C. Bramwell. Briefly states the writer's conclusions concerning the wire and the tubular wheels. 500 w. Horseless Age—June 26, 1901. No. 41854.

I. Experience of Users. Dr. H. L. Stickney. I. I. Jules Junker. Considers the merits of wheels and tires. 6500 w. Horseless Age—June 26, 1901. No. 41859.

Some New Ideas in Wheels and Tires. Harry E. Dey. An illustrated discussion of design, and the power consumed. 1800 w. Horseless Age—June 26, 1901. No. 41855.

Wood and Wire Wheels. P. M. Heldt. Discusses the construction. Ill. 2300 w. Horseless Age—June 26, 1901. No. 41856.

HYDRAULICS.

Fire Pumps.

Specifications for Fire Pumps. Abstracts of three committee reports presented at the meeting of the Nat. Fire Protective Assn. 1800 w. Eng News—June 20, 1901. No. 41813.

Flow.

The Flow of Water in Pipes. A discussion of the effect of insufficient experimental investigations of the flow of water on the formulas used in computing pipe sizes. 1500 w. Eng Rec—June 8, 1901. No. 41460.

Hydraulic Elevators.

Valve Gear for High Pressure Hydraulic Elevators. William Baxter, Jr. States where the high-pressure system is advantageous and gives an illustrated description of the general arrangement of the valves for the Otis high-pressure system. 1500 w. Am Mach—June 6, 1901. No. 41434.

Lachine Rapids.

See Electrical Engineering, Generating Stations.

Plumbing.

Plumbing in the Temple Bar Building, Brooklyn. Illustrated description of the work in a 14-story office building, having closed pressure tanks in the top story from which the building is supplied, through reducers where the pressure is too great. 1500 w. Eng Rec—May 11, 1901. No. 40873.

Siphoning.

Experiments Bearing on the Siphoning of Closet Traps. An illustrated record of the results of experiments carried out on the apparatus fitted in the Parkes Museum. 1500 w. Jour San Inst—April, 1901. No. 41276 F.

Tank Failure.

Failure of a Cast-Iron Tank. P. Hutchison. Description of the tank, the failure and the cause. Ill. 600 w. Prac Engr—May 24, 1901. No. 41348 A.

Water Motors.

Some Tests of Tangential Water Motors. R. R. Keely. Practical points regarding these motors and account of tests made at Sibley College. Ill. 1400 w. Sib Jour of Engng—June, 1901. No. 41670 C.

MACHINE WORKS AND FOUNDRIES.

Apprenticeship.

The Problem of the Moulder. John G. Sadlier. The slow advancement in foundry practice is discussed and the importance of selecting the right apprentices and educating them. 1800 w. Jour Am Found Assn—June, 1901. No. 41320.

Bevel Gears.

Commercial Bevel Gears for Shafts at Any Angle. W. C. Conant. Showing that the gears listed as standard for driving shafts at right angles to each other may be used for driving shafts whose center lines intersect at any other given angle. 1200 w. Am Mach—June 13, 1901. No. 41574.

Brass.

Melting Brass. C. Vickers. Discusses some points in connection with the handling of crucibles. 1000 w. Jour Am Found Assn—June, 1901. No. 41322.

Brass Foundry.

Fitting Up a Brass Foundry. Illustrates and describes the fitting of a new brass foundry in connection with a plant making brass fittings for steam and gas. 1400 w. Am Mach—June 20, 1901. No. 41811.

Clutch.

A New Friction Clutch. Thomas Henry Smith. Illustrates and describes the Philips friction clutch. 1000 w. Eng News—June 6, 1901. No. 41456.

Cores.

Green Sand Cores. P. R. Ramp. On the advantages of the green sand cores, and directions for making them. 1500 w. Jour Am Found Assn—June, 1901. No. 41317.

Costs.

Foundry Costs. R. C. Cunningham.

Calls attention to points affecting the economy, and offers suggestions. 1800 w. Jour Am Found Assn—June, 1901. No. 41321.

Cranes.

A 45-Ton Locomotive. Jib Crane. Illustrated description of a crane recently built for the naval station at Port Royal, S. C. 600 w. Eng Rec—June 1, 1901. No. 41343.

Electric Gantry Cranes (Fahrbare Bockkrane mit Elektrischem Autrieb). W. Müller. Illustrated descriptions of two powerful gantries. The various functions in each crane are obtained by gearing driven by single electric motor. 1000 w. Zeitschr d Ver Deutscher Ing—May 18, 1901. No. 41711 D.

Dies.

Bending Dies. Jos. V. Woodworth. Illustrated description of punch and dies. 600 w. Am Mach—May 30, 1901. No. 41294.

Drills.

Twist Drill Tests. Eugene C. Peck. Description of a testing apparatus which automatically records the feed pressure and the torsional stress on a drill in operation. 1000 w. Am Mach—May 30, 1901. No. 41293.

Engraving.

Engraving Machine. Illustrated description of an instrument which will produce both lettering and designs either sunk or in relief on metals and other materials. 1400 w. Engng—May 24, 1901. No. 41367 A.

Expense.

The Proper Distribution of the Factory Expense Burden. A. Hamilton Church. The first of a series of papers dealing with this important subject, treats of the interlocking of general expense with price costs. 3500 w. Engineering Magazine—July, 1901. No. 41773 B.

Foundry.

Foundry Metallurgy. Herbert E. Field. Discusses the results that may be expected and how they are best accomplished, with questions related to the mixing of irons. 5000 w. Jour Am Found Assn—June, 1901. No. 41376.

The Foundry, Its Equipment and Management. Edwin B. Gilmour. Discusses what a modern foundry should be when quantity and quick delivery are of greatest importance. Ill. 3000 w. Jour Am Found Assn—June, 1901. No. 41325.

Gear Teeth.

Table for the Strength of Gear Teeth by Diametrical Pitch. Gives table based on the Lewis formula, with explanation. 400 w. Am Mach—June 20, 1901. No. 41810.

Key Seaters.

Keyseaters at the Glasgow Exhibition. Illlustrated description of machine tools of this class; two of British manufacture and the remainder from the United States. 2300 w. Engng—May 31, 1901. No. 41501 A.

Krupp Works.

The Krupp Works. From *L'Illustration.* Illustration of the proving grounds, with information concerning these noted works. 1800 w. Sci Am Sup—June 1, 1901. No. 41288.

Machine Works.

The German Niles Machine Shop (Die Deutsche Niles-Werkzeug maschinen-Fabrik). A very full account of the new machine-tool building establishment at Ober-Schöneweide, near Berlin. 5000 w. 3 plates. Zeitschr d Ver Deutscher Ing—May 25, 1901. No. 41712 D.

The Shops of the Willans & Robinson Company, at Rugby, England. An illustrated description of some interesting things seen when the Am. Soc. of Mech. Engrs. were entertained by this firm. 3800 w. Am Mach—June 6, 1901. No. 41433.

Management.

Control of the Foundry. Percy Longmuir. On the relation of laboratory and foundry and the education needed by the manager. 1600 w. Jour Am Found Assn —June, 1901. No. 41318.

Mixing Iron.

Effects of Variations in Manganese on Different Grades of Iron. Thomas D. West. Tabulated results from a wide range of experiments, with an outline of the method of testing. Ill. 2000 w. Jour Am Found Assn—June, 1901. No. 41378.

The Relation of the Laboratory to the Foundry. Percy Longmuir. Discusses the advantages of the laboratory in connection with foundry work. 2200 w. Jour Am Found Assn—June, 1901. No. 41324.

The Value of Mixing by Analysis. Jas. A. Murphy. Suggestions for foundry work, with the writer's method of recording pig iron shipments. 1100 w. Jour Am Found Assn—June, 1901. No. 41377.

Molding.

Molding a Crosshead Guide with a Pattern Which Makes Its Own Core. R. H. Palmer. Illustrated description of the method. 1200 w. Am Mach—June 20, 1901. No. 41809.

Packing.

Some Characteristics of Waste Packing. T. H. Symington. An account of investigations, giving a more exact method of determining the value of various wastes for this purpose, with general discussion. Ill. 3200 w. W Ry Club—May, 1901. No. 41801 C.

Ordnance.

The 16-Inch Breech-Loading Rifle, Type, Model 1895. J. P. Farley. Report containing description of gun and its construction, with many plates. 8500 w. Jour U S Art—May-June, 1901. Serial. 1st part. No. 41602 D.

Planing.

A Link Planing Fixture. Nicholas B. Miller. Illustrates and describes an attachment used for planing links, link blocks and quadrants. 500 w. Am Mach —June 13, 1901. No. 41577.

Ram Pressure.

Testing Ram Pressures in Presses. Oberlin Smith. Describes the system used by the writer which is nearly enough accurate for most practical purposes. 1300 w. Am Mach—June 20, 1901. No. 41808.

Shop Heating.

Heating in the Fore River Engine Company's Shops. Illustrated description of a hot-blast system of mechanical heating and ventilation in two large buildings having considerable exposure. 1500 w. Eng Rec—June 1, 1901. No. 41346.

The Heating of Workshops (Ueber Fabrikheizungen). Otto Marr. An examination of the prevailing conditions, and a discussion of the use of exhaust, mixed, and high pressure steam, as well as hot air and gas. The preference is given to exhaust steam, aided by reduced pressure steam from the boilers. Two articles, 5000 w. Gesundheits-Ingenieur —April 30, May 15, 1901. No. 41762 each B.

Shops.

A Machine Shop on Wheels. George D. Campbell. An illustrated description of a novel traveling shop. 700 w. Am Mach—May 2, 1901. No. 40707.

Tools.

Three Box Tools and Some Other Fixtures. A. H. Cleaves. Illustrated description of special box tools for turret lathe work, tools for counter-sinking rivets, a die holder and a graduating tool. 900 w. Am Mach—June 13, 1901. No. 41576.

Wastes.

Utilization of the Wastes From the Use of White Metals. Joseph Richards. The writer's experience in the utilization of tin clippings, galvanized iron scrap, and other wastes from metallurgical operations. 3600 w. Jour Fr Inst—June, 1901. Serial. 1st part. No. 41617 D.

MATERIALS OF CONSTRUCTION.

Alloys.

Obtaining the Approximate Weight of Alloys Before Making. Walter J. May. An explanation of a simple method. 1500 w. Prac Engr—June 14, 1901. No. 41824 A.

Cast Iron.

Influence of Titanium on the Properties of Cast Iron. Auguste G. Rossi. The writer's experience in using ores containing titanium, with report of tests made to show the effect of adding various quantities of ferro-titanium to ordinary foundry mixtures. 3600 w. Jour Am Found Assn—June, 1901. No. 41319.

Report of the Committee on Standardizing the Testing of Cast Iron. Ill. 3000 w. Jour Am Found Assn—June, 1901. No. 41379.

Drop Tests.

Experiments in Flexure by Drop Tests. (Quelques Expériences de Flexion par Choc.) J. Barba. Data and results of the method of drop test upon nickel test bars; the experiments being conducted in the shops of the Eastern Railway of France. 3500 w. Mem Soc Ing Civ de France—April, 1901. No. 41727 G.

Flow.

The Flow of Metal. Henrik V. Loss. An account of recent experiments supporting the writer's statement that the accepted power to punch steel is decidedly an unnecessarily large one. Discussion. 1500 w. Jour Fr Inst—June, 1901. No. 41618 D.

India Rubber.

India-Rubber and Its Sources of Supply. Briefly reviews the past supply and what is being done to ensure the supply for the future. 3000 w. Engr, Lond—May 31, 1901. No. 41496 A.

Matter.

Extension of the Group Theory of Atoms and Molecules. Arthur A. Skeels. Results and conclusions of several years' study of the laws governing the properties and phenomena of matter. 6200 w. Jour Assn of Engng Socs—March, 1901. No. 40991 C.

Metal Expansion.

On the Expansion of Certain Metals at High Temperatures. Ludwig Holborn. An account of investigations by a new method, with tabulated report of observations. 5000 w. Am Jour of Science—May, 1901. No. 40618 D.

Resistance.

The Study of the Resistance of Materials (Zur Festigkeitslehre). O. Mohr. A general review of the physical problems involved in the study of the resistance of materials. 3000 w. Zeitschr d Ver Deutscher Ing—May 25, 1901. No. 41714 D.

Steel Castings.

The Properties of Steel Castings. John Oliver Arnold. Read before the Iron & Steel Inst. An illustrated account of researches commenced about six years ago in the steel works and laboratories of the Sheffield (Eng.) Univ. College. 4200 w. Engng—June 7, 1901. Serial. 1st part. No. 41611 A.

Testing.

Tension Tests with Nicked Test Bars (Zugversuche mit Eingekerbten Probekörpern). A. Martens. Data and results of trials with the system of Prof. Barba, as applied at the Charlottenburg laboratory. 5000 w. Zeitschr d Ver Deutscher Ing—June 8, 1901. No. 41717 D.

POWER AND TRANSMISSION.

Bearings.

Anti-Friction Bearings. Illustrated examples of devices for reducing frictional resistances. 4200 w. Mach, N. Y.—June, 1901. No. 41411.

Chains.

Chain and Chain Gearing. Charles Piez. Illustrated discussion of the principle of chain gearing, the care needed, etc. 2200 w. Am Mfr—May 30, 1901. No. 41296.

Crank.

The Velocity Relations of a Cranked Quadrangle (Ueber den Beschleunigungs zustand eines Kurbelvierecks). Dr. A. Herzog. A geometrical analysis of velocity ratios in a four-sided linkage, using the method of instantaneous centers. 1200 w. Schweizerische Bauzeitung—May 11, 1901. No. 41755 B.

The Dynamics of Crank Driving (Dynamik der Kurbelgetriebe). Dr. H. Lorenz. An analytical study of the relations of the tangential and rotative forces in driving a crank by a connecting rod. 25000 w. Schiffbau—June 8, 1901. No. 41722 D.

SPECIAL MOTORS.

Gas Engines.

Types of Gas Engines in Most Common Use. Fritz W. Lurmann. Condensed translation from *Stahl und Eisen*. States the fundamental principles upon which gas motors are constructed, and points out their differences. Ill. 1200 w. Ir & Coal Trds Rev—June 7, 1901. No. 41607 A.

Gasoline Engines.

Cylinder, Piston and Packing Rings. L. Berger. Considers French and American practice, and gives information relating to the packing. 1500 w. Horseless Age—June 5, 1901. No. 41430.

STEAM ENGINEERING.

Boilers.

A Boiler-Shell Chart. Lawford H. Fry. Chart, with explanation and illustration of its use. 800 w. Am Engr & R R Jour—June, 1901. No. 41442 C.

Calculating the Strength of Steam Boilers. W. H. Wakeman. Some points concerning tensile strength, joints, and bursting pressure. 1000 w. Elec, N. Y.—June 12, 1901. No. 41572.

Steam Boiler Economy. William Kent. Abstract of a lecture delivered before Sibley College. Discusses the design of the plant and points affecting the economy. 1500 w. Sib Jour of Engng—June, 1901. No. 41668 C.

The Cahall Water-Tube Boiler. States the 12 requirements that George H. Babcock considered necessary for a perfect steam boiler, and gives an illustrated description of this boiler which claims to fulfill them. 2200 w. Ir & Coal Trds Rev—June 14, 1901. No. 41844 A.

The Dürr Water-Tube Boiler. Illustrated description and general information of this boiler. H. M. S. "Medusa" is to be fitted with eight boilers of this type. 2200 w. Engr, Lond—May 31, 1901. Serial. 1st part. No. 41492 A.

The Transmission of Heat Through Scale-Covered Boiler Tubes. Edward C. Schmidt. Gives tabulated results of tests made at the Univ. of Illinois, for the purpose of measuring the number of heat units transmitted per hour through the different tubes; describes methods used. 1000 w. R R Gaz—June 14, 1901. No. 41651.

The Work Done in a Boiler. Editorial discussing the boiler as an efficient converter of heat into work. 2400 w. Engr, Lond—May 24, 1901. No. 41364 A.

Water-Tube Boilers in the Navy. A letter from Marquis de Chasseloup Laubat, discussing the "interim report" of the Water-Tube Boiler Committee. 3800 w. Engng—May 24, 1901. No. 41368 A.

Boiler Test.

Evaporation Test of Dürr Boilers (Verdampfungs-Versuch an Dürr kesseln). Data and results of Dürr boilers fired with producer gas and provided with superheaters. 1000 w. Glückauf—May 18, 1901. No. 41730 B.

Brooklyn Navy Yard.

The Steam Engineering Power Station at the Brooklyn Navy Yard. Illustrated description of the electric generating station built to furnish power to the extensive engineering shops at the Brooklyn Navy Yard. 2800 w. Eng Rec—June 1, 1901. No. 41339.

Engine Balancing.

The Geometry of Engine Balancing. J. Macfarlane Gray. Read before the Inst. of Nav. Archts. Considers the drawing-office methods of applying the principles of engine balancing. Ill. 4600 w. Engng—May 31, 1901. No. 41504 A.

Engine Tests.

Test of the Corliss Engine at the Saratoga Mine, Central City—Some Pumping Data. Thomas L. Wilkinson. Abstracts of a paper read before the Colorado Scientific Society. Remarks on the importance of engine testing, with report of the test named. 1500 w. Min Rept—June 20, 1901. Serial. 1st part. No. 41846.

Forced Draft Test.

Some Results of a Test of Heating and

Ventilating Apparatus. O. B. Zimmerman. A statement of the conditions and a test where 96 observers were used after having special drill, and the results. 2300 w. Wis Engr—May, 1901. No. 41386 D.

Grates.

The Kudlicz Grate. L. Brousse, in *L'Ingénieur Français.* Illustrates and describes a grate intended to solve the problem of continuous mechanical feed, stoking or clearing the firebars, and removing the products of combustion. 1000 w. Col Guard—May 31, 1901. No. 41505 A.

Marine Engines.

The Steamships "Port Royal" and "Port Antonio." Illustrated description of the triple-expansion engines of two steamships constructed to be worked under a government subsidy for the development of U. S. trade with the West Indies. 1500 w. Sci Am Sup—June 29, 1901. No. 41866.

Oil Filters.

Filters for Removing Oil and Mud from Boiler Feed-Water. Illustrated description of a filter used both in land and marine boiler plants. 700 w. Eng News—June 13, 1901. No. 41583.

Paper Making.

Steam Engineering in Paper and Pulp Mills. W. D. Ennis. A study of steam economy in an important steam-using industry. Engineering Magazine—July, 1901. No. 41776 B.

Piping.

Standard Pipe Dimensions for High-Pressure Steam (Normalien zu Rohrleitungen für Dampf von Hoher Spannung). A discussion of the standard pipe and flange dimensions adopted by the *Verein Deutscher Ingenieure.* 3500 w. 1 plate. Gesundheits-Ingenieur—April 15, 1901. No. 41759 B.

Pistons.

Extension Piston Rods and Wear of Locomotive Cylinders. J. L. Doherty. Statements, with illustrations, bearing upon this subject, and the writer's opinion. 1800 w. R R Gaz—June 14, 1901. No. 41649.

Powdered Fuel.

Powdered Fuel for Boiler Furnaces at the Alpha Cement Co.'s Works, Alpha, N. J. Illustrates and describes the apparatus and its operation for preparing the powdered fuel. 1400 w. Eng News—June 20, 1901. No. 41815.

Power Plant.

The Mechanical Plant of a Baltimore Office Building. Illustrated description of the steam, elevator, lighting, telephone, heating and ventilating plant in the building of the Maryland Telephone and Telegraph Co. 3800 w. Eng Rec—May 4, 1901. No. 40727.

Some Mechanical Details in High Office Buildings. Notes on the elevator equipment, chimneys, and other plant, given in a paper by R. P. Bolton before the Inst. C. E. 800 w. Eng Rec—June 1, 1901. No. 41344.

Prime Movers.

Determination of the Angular Displacement of Prime Movers. Lionel Fleischmann. Mathematical demonstration showing that the angular displacement is not only dependent upon the maximum change in speed, but also determined by the general character of the velocity curve. 800 w. Elec Wld & Engr—June 1, 1901. No. 41404.

Quadruple Expansion.

Quadruple Expansion Steam Engine (Machine à Vapeur à Quadruple Expansion). G. Eude. A description of the Bourdon trunk quadruple expansion engine, exhibited at Paris. 1800 w. Génie Civil—June 8, 1901. No. 41707 D.

Smoke.

The Smoke of Paris (Les Fumées de Paris). An examination of the pollution of the air of Paris by smoke and a discussion of the measures taken for smoke prevention. 1800 w. Génie Civil—May 25, 1901. No. 41705 D.

Steam Engines.

Eight Thousand Horse Power Engines for the Manhattan Power Station. Illustrated detailed description of these powerful steam-operated machines. 1700 w. Power—June, 1901. No. 41426.

Steam Engines at the Glasgow Exhibition. The present article describes Robey & Co.'s horizontal cross-compound engine. Ill. 2200 w. Engr, Lond—May 31, 1901. Serial. 1st part. No. 41493 A.

Steam Engine for Walker-on-Tyne Electric Station. Illustrated description of a 1400 indicated horse-power set of triple-expansion engines, specially interesting in view of the great economy attained in steam consumption. 700 w. Engng—June 14, 1901. No. 41836 A.

Steam Turbine.

A Test of a Steam Turbine. F. E. Cardullo. Reports a test on the Parsons steam turbine at Sibley College. Ill. 2000 w. Sib Jour of Engng—June, 1901. No. 41-667 C.

Trial of a Turbo-Generator After Twelve Months Working. An interesting report by Prof. Ewing, giving particulars of a test of Parsons turbo-generator. 1400 w. Engng—June 14, 1901. No. 41837 A.

The Parsons Steam Turbine (Turbine à Vapeur Parsons). M. Duchanoy. A review of the progress of the steam turbine, describing exhibit at Paris, and details of recent tests. 2000 w. Génie Civil—May 18, 1901. No. 41700 D.

Valve Motion.

Link Motion and Piston Valves. C. A.

Seley. Discusses the extensive use of piston valves, their location, various styles and their advantages. 1800 w. Am Engr & R R Jour—June, 1901. No. 41441 C.

MISCELLANY.

Absolute Temperature.

Concerning Absolute Temperature. Explains the term as used in the temperature scale of the perfect gas thermometer, showing the line of reasoning by which the existence of the absolute zero is established. 3500 w. Locomotive—April, 1901. No. 41064.

Address.

Mattoids in Engineering. H. F. J. Porter. Extracts from a paper presented to the Am. Water Wks. Assn. Remarks on the growing tendency to assume the truth of certain statements of facts without investigation, and whose misconceptions lead often to danger. Several examples are given in illustration. 2800 w. Eng Rec—June 22, 1901. No. 41874.

Air Compressors.

Double Compound Compressor (Zwillings-Verbund Kompressor). Illustrated description and account of tests of air compressor at the Emscher pit of the Cologne Mining Company. Indicator diagrams from steam and air cylinders are given. 1200 w. 2 plates. Glückauf—May 25, 1901. No. 41732 B.

Inlet Valves and Their Relation to the Efficiency and Volumetric Capacity of Air Compressors. Fred. Brainard Corey. Calls attention to some of the peculiarities of inlet valves of the usual types with the object of aiding the designer and user in making an intelligent choice. 2300 w. Eng News—May 30, 1901. No. 41304.

Some German Air-Compressors. Illustrations and particulars relating to the Humboldt compressor, and also the Dingler compressor. 1800 w. Quarry—June 1, 1901. No. 41593 A.

Air Currents.

Changes in Velocity and Direction of Air Currents (Changements der Direction et de Vitesse d'un Courant d'Air). M. Marey. An examination of the influence of resisting bodies of various forms in the path of air currents. 1800 w. Comptes Rendus—June 3, 1901. No. 41739 D.

Artillery.

Boer Field Artillery. An illustrated discussion of some of the field guns used by the Boers, purchased from the best French, German and Austrian gun-making firms. 3500 w. Engr, Lond—April 26, 1901. No. 40810 A.

The Development of the Mode of Ignition in Small Arms and Artillery. A review of the progress of invention in this field, with illustrations. 2700 w. Engr, Lond—May 10, 1901. Serial. 1st part. No. 41037 A.

Chronometers.

A Practical Method of Correcting the Secondary Error of Chronometers (Procédé Pratique pour la Correction de Erreur Secondaire des Chronometres). C. E. Guillaume. Showing that the very slight expansibility of certain nickel-steel alloys makes it suitable for balance springs for chronometers. 1000 w. Comptes Rendus—May 6, 1901. No. 41736 D.

Flow.

The Flow of Semi-Fluids Through Orifices. Willis Whited. The experiments described were performed with wheat. Also discussion. Ill. 3400 w. Pro Engs Soc of W Penn—April, 1900. No. 41603 D.

Heating Plant.

Heating in the Marion County Court House, Fairmont, W. Va. Illustrated description of a plant for warming a building by means of a fan forcing heated air through underground ducts to the various flues leading to the rooms. 1800 w. Eng Rec—May 25, 1901. No. 41218.

Heating the Reptile House at Bronx Park, New York. Illustrated description of a low-pressure hot-water apparatus designed to maintain a temperature of 80° in zero weather. 1400 w. Eng Rec—June 22, 1901. No. 41875.

Name Plates.

Name Plates. Edmund S. Sperry, in the *Aluminum World*. Describes methods of making and attaching such plates. 1400 w. Foundry—June, 1901. No. 41281.

Pistol.

The Luger Automatic Pistol. Grahame H. Powell. An illustrated description of the weapon and its operation. 1000 w. Am Mach—May 16, 1901. No. 40939.

Refrigeration.

A "Boer" Cold Storage Plant in South Africa. Illustrates and describes the plant at Durban, S. Africa. 4800 w. Ice & Refrig—June, 1901. No. 41407 C.

Cold Air Refrigeration. H. Muenster. Describes an example of abattoir refrigeration on the cold air system in Germany. 2000 w. Ice & Refrig—June, 1901. No. 41409 C.

Cold Storage at Nome, Alaska. Brief illustrated description of a plant at Nome City. 1000 w. Ice & Refrig—June, 1901. No. 41408 C.

The Plant of the Norfolk Refrigerating Storage Company. Illustrated description of a refrigerating and ice-making plant with an underground conduit for the public supply of refrigerating brine. 2200 w. Eng Rec—June 8, 1901. No. 41468.

Slide-Rule.

The Use of Calculating Machines. Charles A. Holden. Urging the use of the slide rule to a greater extent. 900 w. Eng News—May 30, 1901. No. 41309.

MINING AND METALLURGY

COAL AND COKE.

Coal Handling.

See Electrical Engineering, Power Applications.

Coal Problem.

The Coal Problem: Its Relations to the Empire. Carlyon W. Bellairs. A survey of the existing position of England, with conclusions. Appendix and discussion. 7000 w. Jour Soc of Arts—June 7, 1901. No. 41599 A.

Coke Plant.

See Electrical Engineering, Power Applications.

Colliery Management.

The Management and Control of the Colliery. Wm. Blakemore. Mr. Blakemore's first paper is devoted to the discussion of standard practice in opening up the mine and conducting the underground workings. 3000 w. Engineering Magazine—July, 1901. No. 41777 B.

Explosion.

Colliery Explosion in South Wales. An account of a terrible explosion involving the death of 82 miners, occurring on the 24th of May at the Universal Colliery. 2800 w. Col Guard—May 31, 1901. No. 41507 A.

The Gas Explosion in the Frischglück Mine at Dux (Die Brandgas explosion auf der Frischgluchzeche bei Dux). F. Okorn. A description of the disastrous gas explosion which occurred at Dux, in Bohemia, September 19, 1900, with an examination of the causes. Serial. Part I. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—June 1, 1901. No. 41-735 B.

The Port Royal Mine Explosion. An account of the explosions on June 10th, with editorial on the prevention of mine accidents. 1800 w. Eng & Min Jour—June 22, 1901. No. 41802.

Faunal Studies.

Coal Measures Faunal Studies. J. W. Beede and Austin F. Rogers. The first of a series of papers giving lists of the faunas of the different horizons of the Coal Measures of Kansas and certain parts of western Missouri. 5000 w. Kansas Univ Qr—Oct., 1900. Serial. 1st part. No. 41851 D.

Pennsylvania.

The Latrobe Coal and Coking Field in Pennsylvania. William G. Irwin. Brief account of this district and its recent development. 1000 w. Eng & Min Jour—June 8, 1901. No. 41510.

Pioneer Work.

Pioneer Work in the Crows Nest Coal Areas. William Blakemore. An account of the opening of this mine in the Rocky Mts., the difficulties, etc., describing the appliances, plant and machinery installed. Maps. 5800 w. Can Min Rev—May 31, 1901. No. 41420 B.

Queen Charlotte Is.

The Coal and Asphaltum Deposits of the Queen Charlotte Islands. W. F. Best. Information concerning these deposits and the exploration work on the islands off British Columbia. 1300 w. B. C. Min Rec—June, 1901. No. 41515 C.

Siberia.

Coal in East Siberia. Concerning the sources of supply for this region. 1200 w. U. S. Cons Repts, No. 1069—June 22, 1901. No. 41686 D.

Spain.

Rivals to British Coalfields. The present article considers the coalfields of Castile, in Spain, which have recently come into prominence. 1800 w. Ir & Coal Trds Rev—May 31, 1901. Serial. 1st part. No. 41509 A.

Statistics.

The Value of Coal and the Average Wages of Coal Miners. Tabulated statistics showing output, wages, value at pit's mouth, etc., based on the British Home Office statistics. 800 w. Col Guard—May 24, 1901. No. 41371 A.

Trans-Mississippi Coals.

Horizons of Arkansas and Indian Territory Coals Compared with those of Other Trans-Mississippian Coals. Charles R. Keyes. A geological study of these beds. Ill. 2000 w. Eng & Min Jour—June 1, 1901. No. 41327.

COPPER.

American Copper.

Copper Mining in America. Waldon Fawcett. A review of the rapid development of this industry, the improvement in methods and facilities for mining, etc. Ill. 1600 w. Sci Am—June 8, 1901. No. 41449.

Deposits.

The Deposits of Copper-Ores at Ducktown, Tenn. J. F. Kemp. Introductory description of deposits of this type, with topography, geology and petrography of this region, and related information. Ill. 5500 w. Trans Am Inst of Min Engrs—June, 1901. No. 41676 D.

Montana.

The Copper Mines of Butte, Montana, the World's Greatest Mining Camp. Walter Harvey Weed. An illustrated account of the deposits, the geology, mining practice, etc., with information relating to the output, value, etc. 3400 w. Min & Met—June 1, 1901. No. 41541.

New Zealand.

Native Copper in New Zealand. W. H. Baker. Abstract of a paper in London *Mining Journal.* An account of the first lode of copper ore worked, with description of the deposits. 900 w. Eng & Min Jour—June 15, 1901. No. 41568.

GOLD AND SILVER.

Alaska.

The Golovin Bay Region of Northwestern Alaska. J. D. Lowny. Describes the characteristics of the region, its advantages over Nome, and recently organized enterprises. Gold dust assays from $17 to $19 per ounce. 1300 w. Eng & Min Jour—June 15, 1901. No. 41567.

Arizona.

The Mammoth Gold Mine, Arizona. William P. Blake. Abstract of a lecture before the students of the School of Mines, Tucson. Upon methods of working large ore deposits without costly timbering, suggested by the caving in of a large portion of this mine. 1800 w. Min Rept—June 6, 1901. No. 41513.

Assaying.

The Determination of Lead in Ores by Fire Assay. W. Lay. Concerning the sources of error in the fire assay. 1700 w. Can Min Rev—May 31, 1901. No. 41-419 B.

Concentration.

Low Grade Gold Mining and Milling. Describes the practice of a leading mill in the San Juan region of Colorado, and how it is possible for low-grade ores to yield a profit. Ill. 1700 w. Sci Am Sup—June 15, 1901. No. 41591.

The Elmore Process for Concentrating Minerals (Procédé Elmore pour la Concentration des Minerais). J. Dupont. A description of the Elmore process for using oil for the concentration of gold, silver and copper. 1000 w. Génie Civil—May 18, 1901. No. 41703 D.

Cyaniding.

Cyaniding Complex Gold Ores. Frank H. Probert. Notes of interest concerning the bromo-cyanide process. 1000 w. Min & Sci Pr—June 15, 1901. No. 41689.

Gold-Dredging.

Gold-Dredging in California. E. H. Benjamin. Information concerning this industry. At present there are about twenty dredges running, which are producing about $1,000,000 per year. 3000 w. N Z Mines Rec—April 16, 1901. No. 41521 B.

Gold Dredging in the Nome District. G. P. Grimsby. An illustrated description of dredges used at Nome and why they were not successful; also an illustrated description of one being constructed for the work. 1000 w. Eng & Min Jour—June 22, 1901. No. 41807.

The Gold-Dredging Industry in Otago. Table showing capital, gold obtained, and dividends declared, with remarks on this industry. 2000 w. N Z Mines Rec—April 16, 1901. No. 41519 B.

Gold Extraction.

The Union Gold Extraction Company's Mill at Florence, Colorado. John E. Rothwell. Illustrated detailed description of this plant. 4000 w. Eng & Min Jour—June 8, 1901. No. 41511.

Gold-Veins.

The Formation of Bonanzas in the Upper Portions of Gold-Veins. T. A. Rickard. Discusses the results produced by descending surface waters, and other agencies affecting ore deposition. Ill. 7800 w. Trans Am Inst of Min Engrs—June, 1901. No. 41677 D.

Newbury, Mass.

The Lead and Silver Mines of Newbury. Horace C. Hovey. Account of a vein recently opened by quarrymen while blasting rock for the State highway. 700 w. Sci Am Sup—June 15, 1901. No. 41592.

Ore Treatment.

Concentrations of Argentiferous Galena as Carried on at Helena Frisco Consolidated Company's Mills, Gem, Idaho, U. S. A. W. Muir Edwards. Describes the ore treatment at a mine in the Coeur d'Alene district which is celebrated for its lead and silver mining. 5000 w. Can Min Rev—May 31, 1901. No. 41418 B.

Precipitation.

Electrolytic Precipitation From Potassium Cyanide Solutions. J. H. Jory. Describes construction and practice by which the author believes the Siemens-Halske process can be improved. 1200 w. Min & Sci Pr—June 22, 1901. No. 41861.

Production.

Gold and Silver Production of the United States. Tabulated report of gold and silver for the year 1897 to 1900 inclusive, with remarks. 800 w. Eng & Min Jour—June 22, 1901. No. 41803.

Gold and Silver Production of the World. Tabulated estimate for the years 1898 to 1900 inclusive, with remarks. 1800 w Eng & Min Jour—June 22, 1901. No. 41804.

Silver.

Standard Silver: Its History, Properties and Uses. Ernest A. Smith. 1200 w. Sci Am Sup—June 8, 1901. Serial. 1st part. No. 41452.

Smelting.

Pyritic Smelting in the Black Hills. Continued discussion of Prof. Carpenter's paper, presented at the Canadian meeting. 1700 w. Trans Am Inst of Min Engrs—June, 1901. No. 41681 D.

The New Silver-Lead Ore Schedule of the American Smelting and Refining Company. Editorial discussion of the new schedule of payment. 2100 w. Eng & Min Jour—May 11, 1901. No. 40893.

Stamp Mills.

Stamp Mill Practice at Guanagnato. From the *University of Arizona Monthly.* Description. 1400 w. Min Rept—June 13, 1901. No. 41655.

Sulphides.

The Sulphide Problem. Describes the leading features of the Clancy-Marsland process, with report by the recent government geologist of New South Wales. 3700 w. Aust Min Stand—May 2, 1901. No. 41522 B.

Vancouver.

Black Sand Auriferous Deposits of Wreck Bay, Jordan River, and Other Localities of Vancouver Island. R. Lind Watson. Descriptive. Map. 1200 w. Mines & Min—June, 1901. No. 41473 C.

The Mines of Vancouver Island. Illustrates and describes mines of the Mount Sicker district, carrying iron, copper, gold and other metals. 3000 w. B C Min Rec —June, 1901. No. 41514 C.

Veins.

Mineral Vein Formation at Boulder Hot Springs. Walter Harvey Wood. An explanation of the writer's theory as to the genesis of the silver-gold veins of Lump Gulch and other mining districts in Montana. Ill. 2500 w. W. Min Wld—May 25, 1901. No. 41290.

The Role of the Igneous Rocks in the Formation of Veins. J. F. Kemp. Shows the competence of the igneous rocks to supply both the contents of veins and the solutions which are the common carriers of the minerals, and considers the phenomena and the current conceptions of the ground water. 12000 w. Trans Am Inst of Min Engrs—June, 1901. No. 41685 D.

Witwatersrand.

The Gold Fields and Gold Industry of the Witwatersrand (Beschonwingen over de Goudvelden en Goudindustrie van den Witwatersrand). R. de Kat. A general review of the mines and the cyanide plants, with especial reference to the Rose Deep Mine. 3500 w. De Ingenieur—April 27, 1901. No. 41768 B.

IRON AND STEEL.

Cape Breton.

The Manufacture of Iron and Steel in Cape Breton. P. T. McGrath. An account of important newly developed industries which may play an important part in rising international competition. 4000 w. Engineering Magazine—July, 1901. No. 41778 B.

Heat Treatment.

The Heat Treatment of Steel. A review of information on this subject given in recently published papers, especially the investigations of Mr. Albert Sauveur. Ill. 2000 w. R R Gaz—May 31, 1901. No. 41311.

India.

The Iron and Steel Industries of India. C. Ritter von Schwarz. Extract from a series of articles in *Stahl und Eisen.* Reviews the enterprises to establish these industries and utilize the seams of coal and iron ore, and the causes of the failures. 2200 w. Ir & Coal Trds Rev—May 31, 1901. No. 41508 A.

Ingot Stripper.

See Electrical Engineering, Power Applications.

Iron Mine.

The Arragon Mine at Norway, Michigan. E. S. Dickenson. A description of the mine, the machinery used and manner of working. Ill. 2400 w. Mines & Min—June, 1901. No. 41475 C.

Iron Ore.

The First Discovery and Use of Iron Ore in North America. Historical account. 1000 w. Eng News—June 13, 1901. No. 41578.

Iron Sand.

Magnetic Iron Sand of the St. Lawrence Shore. J. Obalski. Read before the Canadian Min. Inst. Concerning the deposits and the processes suggested for agglomerating the magnetic sand. 2500 w. Can Engr—June, 1901. No. 41571.

Ore-Concentration.

Investigations of Magnetic Fields, with Reference to Ore-Concentration. Walter R. Crane. A thesis presented for the degree of Ph. D. at Columbia Univ., N. Y. Describes apparatus and methods of testing, giving the relative magnetic permeability of various iron ores. Ill. 10000 w. Trans Am Inst of Min Engrs—June, 1901. No. 41675 D.

Slags.

The Use of the Tri-Axial Diagram in the Calculation of Slags. Ernest A. Hersam. Presents a method of graphic calculation obtained by extending the work of representation. The example selected deals with the calculation of a blast-furnace slag. 7000 w. Trans Am Inst of Min Engrs—June, 1901. No. 41684 D.

Spanish Ore.

The Spanish Iron Ore Industry. Information concerning this industry in the province of Biscay, the geological formation, system of mining, treatment of the ore, transport, price, etc. 2000 w. Col Guard—May 24, 1901. No. 41373 A.

Steel Anaylsis.

Critical Remarks on McKenna's Method of Analysis of Tungsten and Chrome Steels. The Determination of Tungstic Acid and Separation from Silica. Translation of criticism of Otto Herting, with reply from the author. 1800 w. Pro Engs Soc of W. Penn—April, 1901. No. 41604 D.

MINING.

Deposits.

The Caliche of Southern Arizona: An Example of Deposition by the Vadose Circulation. William P. Blake. Describes the caliche, a deposit of carbonate of lime, and explains its origin. 2200 w. Trans Am Inst of Min Engrs—June, 1901. No. 41679 D.

The Character and Genesis of Certain Contact-Deposits. Waldemar Lindgren. Describes the character of these deposits and discusses their origin. Also discussion by S. F. Emmons. 6500 w. Trans Am Inst of Min Engrs—June, 1901. No. 41682 D.

Diamond Drill.

The Fromholt Electric Drill. From the *Bulletin de la Société d'Encouragement pour L'Industrie Nationale.* Illustrated description of an electrically driven diamond rock drill possessing new and promising features. 1500 w. Col Guard—June 14, 1901. No. 41838 A.

Discipline.

Mine Discipline. D. C. Thomas. Read before the Ohio Min. Engrs. Discusses what constitutes discipline and the importance of system as an aid to its enforcement. 1900 w. Mines & Min—June, 1901. No. 41472 C.

Explosives.

The Causes of Misfire. A. W. Warwick and J. H. Henley. Gives an account of investigations made, with the conclusion that the fault lies in the fuse, and explains some causes. Ill. 1200 w. Min Rept—June 20, 1901. No. 41847.

Fans.

Manometrical Efficiency. J. T. Beard. Explains the meaning of the term which applies to the efficiency of a given circulation and does not express the efficiency of a fan. 1500 w. Mines & Min—June, 1901. No. 41478 C.

Hauling.

Problems in Hauling and Hoisting. Alexander Bowie. Mathematical discussion of problems useful to mining engineers. 600 w. Trans Am Inst of Min Engrs—June, 1901. No. 41678 D.

Hoisting.

Some Recent Designs for Steel Coal-Hoisting Towers. H. G. Tyrrell. Illustrated description of recent designs. 500 w. Eng News—May 30, 1901. No. 41302.

Mine Pumping.

Leadville Pumping Practice. A. W. Warwick. An account of the large volume of water to be handled and the expense and methods. Ill. 2200 w. Min & Sci Pr—June 15, 1901. No. 41688.

Mining Machinery.

Machinery in Ruhr Coal District at the Beginning of the 20th Century (Das Maschinenwesen im Ruhrkohlenbergbau zu Beginn des 20 Jahrhunderts). Dr. H. Hoffmann. Discussing the present employment of electric hydraulic, and pneumatic machinery in the Prussian coal mines. 5000 w. Zeitschr d Ver Deutscher Ing—June 1, 1901. No. 41715 D.

Ottawa, Canada.

Gas and Oil Discoveries Near Ottawa. Description of the investigations, with brief history of the borings, etc. 800 w. Cons Repts, No. 1071—June 25, 1901. No. 41823 D.

Philippines.

Mining Among the Moros in the Philippines. An account of the mining in this portion of the islands, the metals found, transportation, etc. 1900 w. Eng & Min Jour—June 1, 1901. No. 41328.

Pumping Plant.

An Electric Underground Pumping Plant of 800 Horse-Power. States the advantages claimed for electric working of underground pumps, and gives illustrated description of the plant. 1200 w. Ir & Coal Trds Rev—June 14, 1901. No. 41842 A.

Quarrying.

The Helicoidal Wire and Penetrating Pulley for Quarrying Operations. Illustrated description of the penetrating pulley and its operation, giving a statement of the advantages claimed. 1700 w. Stone—May, 1901. No. 41699 C.

Rescue Apparatus.

Rescue Apparatus—An Analogy Between Military and Mining Methods. Reviews experiments made in the mining operations of military engineers, dating back to the latter part of the 18th century. 3300 w. Ir & Coal Trds Rev—May 24, 1901. Serial. 1st part. No. 41860 A.

Rock Drills.

See Electrical Engineering, Power Applications.

Roll Crushing.

Elements in the Design of Roll Crushing Plants. Jesse Scobey. Considers improvements made in rolls since they have been used for fine crushing, and results obtained. 2500 w. Min & Sci Pr—June 1, 1901. No. 41428.

Safety Lamps.

Failures of Safety Lamps Whilst in Use. James Ashworth. On account of some of the disasters and the lessons which may be derived from them. 6600 w. Mines & Min—June, 1901. No. 41474 C.

Influence of the Form of Gauze Mantle Upon the Security of Safety Lamps (Ueber den Ein fluse der Drahtkorbform auf die Durschlagssicherheit der Wetterlamps). H. Fähndrich. A discussion of the best dimensions for the gauze cylinder for safety lamps to prevent the ignition of gases without. 1000 w. Glückauf—May 18, 1901. No. 41729 B.

Shaft Borings.

Some Recent Shaft Borings in the Ruhr District. L. Hoffman. Translated and condensed from *Glückauf.* Information concerning a shaft of the Scharnhorst Colliery, and one at the Preussen II. Colliery. Ill. 2200 w. Ir & Coal Trds Rev—May 24, 1901. No. 41361 A.

Surveying.

Method of Connecting Survey in a Shaft Mine with That of Property Lines and Topographical Features on the Surface. H. L. Auchmuty. Explanatory. 3300 w. Mines & Min—June, 1901. No. 41471 C.

Timbering.

Some Defects in Timbering Underground. An illustrated article dealing with errors in propping. 1800 w. Ir & Coal Trds Rev—May 24, 1901. No. 41359 A.

Tunnels.

Kelly and Newhouse Tunnels. Arthur Lakes. Discusses the sources from which such tunnels derive revenue; how they are planned and the methods used in driving them. Ill. 2100 w. Mines & Min—June, 1901. No. 41477 C.

MISCELLANY.

Bromine.

A Proposed Method for the Extraction of Bromine. Anson G. Betts. On the distribution of bromine, and a proposed method based on its well-known reaction in aqueous solution with phenol. 1000 w. Eng & Min Jour—June 22, 1901. No. 41806.

Elevator.

An Elevator for Smelting Plants. Joel G. Clemmer. Drawings and description of a very well designed and convenient form of elevator for smelting and other plants. 800 w. Eng & Min Jour—June 22, 1901. No. 41805.

Fertilizer.

The Bat Guano Caves of Texas. William B. Phillips. Illustrated description of these enormous caverns containing valuable deposits of fertilizer, some of which are being worked. 3000 w. Mines & Min—May, 1901. No. 40692 C.

Gypsum.

The Gypsum and Cement Plaster Industry in California. G. P. Grimsby. Reviews briefly the different gypsum industries in California. 800 w. Eng & Min Jour—June 8, 1901. No. 41512.

Japan.

Japan and Its Mining Industries. H. L. Geissel. Information concerning the products and the recent development. 1600 w. Min & Met—June 1, 1901. No. 41540.

Mineral Wax.

Ozocerite, or Mineral Wax, in Austria. An account of these deposits, their mining, cleaning, uses, etc. 1500 w. U S Cons Repts, No. 1059—June 11, 1901. No. 41448 D.

Oil.

Prospecting for Oil in Colorado. Arthur Lakes. Considers the signs that may indicate oil, and the geological formations which are favorable. 2200 w. Ill. Mines & Min—June, 1901. No. 41470 C.

The Great Oil-Well Near Beaumont, Tex. Anthony F. Lucas. The history of the well, its control, the oil rock, and oil. Ill. 4000 w. Trans Am Inst of Min Engrs —June, 1901. No. 41683 D.

The New Oil Fields of the United States. David T. Day. Discusses the recent developments in the petroleum industry, especially the California fields and Beaumont, Tex. 2700 w. Am Rev of Revs—June, 1901. No. 41336 C.

The Present Status of the Beaumont Oil Field. Robert T. Hill. An account of the extent of development, the speculation, etc., with a statement concerning the geological conditions. 2800 w. Mfrs' Rec—May 30, 1901. No. 41314.

The Poverty Bay Oil-Bearing Area. Extracts from the progress report of the Government Geologist. 2700 w. N Z Mines Rec—April 16, 1901. No. 41520 B.

Pan-American.

Mining Features of the Pan-American Exposition. I. The Dedication Ceremonies, by Edward W. Parker; II. The Mines Building and Mining Exhibits, by Dr. David T. Day; III. A Tour Through the Building, by Joseph Hyde Pratt; IV. The Petroleum Exhibit, by Harriet Connor Brown; V. Mining Statistics as Shown at Buffalo. Ill. 3500 w. Min & Met—June 1, 1901. No. 41539.

Quicksilver.

The Quicksilver Mines of Brewster County, Texas. E. P. Spalding. An illustrated account of these valuable deposits, the method of prospecting, production, etc. 2000 w. Eng & Min Jour—June 15, 1901. No. 41566.

Sapphires.

Sapphire Mines of Montana. An illustrated account of these valuable gem mines, the methods of working stones found, etc. 1500 w. W Min Wld—June 1, 1901. No. 41429.

Tasmania.

Mining in Eastern Tasmania. H. Grant. An account of the tin mining, the deposits and their development. 3500 w. Aust Min Stand—May 9, 1901. No. 41627 B.

Zinc.

The Zinc Combine. Editorial discussion of the combination of European zinc producers. 1000 w. Engng—May 3, 1901. No. 40848 A.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in April. Detailed list and classified summary. Also information concerning the I. C. C. accident reports. 4700 w. R R Gaz—June 7, 1901. No. 41537.

Collisions.

Oil-Car Collisions. Editorial discussion of recent collisions with oil trains. 1100 w. R R Gaz—June 21, 1901. No. 41822.

Derailments.

Car Trucks, Car Wheels, and Derailments. Editorial discussion of certain features in connection with the design of rolling stock. 1700 w. Eng News—June 20, 1901. No. 41814.

Freight Handling.

Unloading a Heavy Shaft. Illustrated directions for safely unloading a crank shaft, skidded and lying on a flat car. 3000 w. Power—June, 1901. No. 41427.

Interurban.

Some Observations on Interurban Electric Railways. Walter J. Sherman. Reviews briefly the pioneer work in this field, and discusses the present problem of furnishing rapid transit and give satisfactory earnings. 1800 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41-389 D.

Pan-American.

The Pan-American Exposition. General remarks on the exposition, with illustrated description of the transportation exhibits. 7800 w. Ry & Engng Rev—June 15, 1901. No. 41662.

Train Resistance.

Center Plate Friction and Its Effect on Wheel Flange Resistance. Willis C. Squire. A discussion of experimental investigations and their results. Also tables and general discussion. 7800 w. W. Ry Club—May, 1901. No. 41800 C.

FINANCIAL.

Accounts.

Material Accounts. A. D. Parker. Address at meeting of the Assn. of Am. Ry. Accounting Officers. Describes the methods of handling material accounts, offering suggestions. 4000 w. Ry Age—June 7, 1901. No. 41553.

The Store Room and Store Room Accounts. Benjamin W. Tingley. Discusses methods of keeping accounts in the store rooms of street railways. 2500 w. St Ry Jour—June 1, 1901. No. 41414 D.

High Speed.

Cost of Running Trains at High Speed. Considers the cost of running trains at high speed as affected by mechanical considerations. 4800 w. Am Ry Mas Mechs' Assn—Saratoga meeting, 1901. No. 41-623 C.

Train Speeds.

Economical Train Speeds. G. R. Henderson. Diagrams showing results of experiments from the fuel standpoint, with explanatory notes. 1800 w. Am Engr & R R Jour—June, 1901. No. 41436 C.

MOTIVE POWER AND EQUIPMENT.

Accumulators.

Storage Battery Auxiliaries. Lamar Lyndon. Describes the various booster systems in use and shows the conditions to which each is suited. 2000 w. Elec Wld & Engr—June 8, 1901. No. 41548.

Air Brakes.

The Maintenance of Air Brakes on Freight Cars. G. W. Rhodes. Considers what methods should obtain to insure the cleaning of triples at least once in every 12 months; and should there be few or many cleaning stations on a railroad or system of railroads. 1300 w. Am Engr & R R Jour—June, 1901. No. 41435 C.

Berlin.

Electric Driving on the Berlin Belt Railway (Der Elektrische Betrieb auf der Berliner Stadt und Ringbahn). D. Pforr. An examination of the conditions of operation of the Berlin municipal railway in view of the substitution of electric driving for steam. 2200 w. Glasers Annalen—June 1, 1901. No. 41725 D.

Brake Shoes.

The Friction of Brake Shoes. R. A. Parke. Reviews experiments to date, and discusses the effect of pressure, speed, continued rubbing, temperature, etc. 8000 w. R R Gaz—June 14, 1901. Serial. 1st part. No. 41650.

Buffalo Railways.

The Street Railways of Buffalo and Vicinity. Illustrated description of the lines of the International Traction Co., their operation and connecting lines. 14000 w. St Ry Rev—June 15, 1901. No. 41-666 C.

Car Building.

Steel in Car Building. John M. Housen. On the advantages of the steel underframe. 2000 w. R R Gaz—June 14, 1901. No. 41640.

Car Construction.

Pressed Steel System of Car Construction. An estimate of the economies realized by the use of steel cars. Ill. 2200 w. Sci Am—June 22, 1901. No. 41665.

Car Heating.

The Heating of Railway Cars (Le Chauffage des Voitures de Chemins de Fer). H. Guérin. An exhaustive review of the great improvements in heating railway carriages in France as shown by the expositions of 1889 and 1900. Three articles. 6000 w. Génie Civil—May 18, 25, June 1, 1901. No. 41702 each D.

Car Motoring.

Four Motors v. Two. Reviews ideas advanced in the papers of Messrs. Pestell and Bigelow, and discusses the subject from the English viewpoint. 2300 w. Elec Rev, Lond—May 31, 1901. No. 41489 A.

Cars.

80,000-lbs. Capacity Box Car—Central of Georgia. Illustrated description of one of 300 cars now being built from this design. 1200 w. R R Gaz—June 21, 1901. No. 41820.

80,000-lbs. Capacity Steel Dump Car—Atchison, Topeka & Santa Fe. Illlustrated description. 800 w. R R Gaz—June 14, 1901. No. 41647.

New Parlor and Cape Dining Cars, B. & O. R. R. Half-tone illustrations and floor plant, with description. 400 w. Ry & Engng Rev—June 22, 1901. No. 41849.

New Passenger, Dining and Observation Cars. Brief illustrated descriptions of a few examples of recent design. 1100 w. Eng News—June 20, 1901. No. 41812.

100,000-lb. Ore Car; Chicago, Milwaukee & St. Paul Ry. Illustrated detailed description. 1000 w. Eng News—June 20, 1901. No. 41817.

Philadelphia & Reading Box Cars with Steel Underframes. Illustrated description of a design for 500 box cars of 50,000-lbs. capacity. 1200 w. R R Gaz—June 21, 1901. No. 41821.

The Ingoldsby Dumping Car. Illustrates and describes both the steel and wood construction. 1400 w. Ry & Engng Rev—June 22, 1901. No. 41850.

Car Ventilation.

New Ventilating System for Passenger Cars. Illustrates and describes with some detail, the system which has been applied to over 200 cars of the Pennsylvania Railroad. 5000 w. Am Engr & R R Jour—June, 1901. No. 41437 C.

Car Wheels.

The Further Development of Cast Iron Wheels. S. P. Bush. Suggestions for the improvement of the wheels by a change in the contour. 800 w. R R Gaz—June 14, 1901. No. 41646.

Cleveland, Ohio.

Improvements on the Cleveland Electric Railway. Illustrated description of the interesting features. 1300 w. St Ry Jour —June 1, 1901. No. 41416 D.

Couplers.

The Freight Car Coupler Situation. Edward Grafstrom. Discusses drop testing machines, the coupler contour gauge, the "angling test," etc. 1300 w. Ry Mas Mech—June, 1901. No. 41316.

Coupler Tests.

Tests of the M. C. B. Couplers. Report of the standing committee concerning the tests of the last year. 4300 w. Am Mast Car Bldrs' Assn—Saratoga meeting, 1901. No. 41621 C.

Draft Gear.

The Draft Gear Situation. Edward Graftstrom. Discusses recent tests and what they demonstrate; also a reply to this article in a letter from E. M. Herr. 2400 w. Am Engr & R R Jour—June, 1901. No. 41447 C.

Electric Traction.

Electric Traction on Main Line Railways (Der Elektrische Betrieb von Vollbahnen). Fr. Ross. With especial reference to the operation of the section of the Valtellina Railway, between Lecco and Chiavenna by electric locomotives, using the hydraulic power of the Adda. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—May 24, 1901. No. 41718 B.

The Ganz Electric Line of Valtellina. Illustrated description of a line representing the highest development of the Ganz three-phase high-tension system of electric traction. 800 w. Sci Am—June 29, 1901. No. 41863.

Fireboxes.

Wide Fireboxes for Soft Coal. F. A. Delano. A review of recent changes in the designs of fireboxes and why they were made. 1200 w. Am Engr & R R Jour—June, 1901. No. 41438 C.

Freight Cars.

Comparative Efficiencies of Freight Cars, With Some Observations Concerning Their Design. George I. King and Albert Pancoast. Discussion of this subject, with observations on car design in general and a plea for designs in accordance with known laws and facts of structural and mechanical engineering. 2000 w. R R Gaz—June 14, 1901. No. 41654.

Fuel Consumption.

Saving in Fuel Consumption by the Compound Locomotive. C. J. Mellin. Gives a table showing the results collected from various records of performances in regular service and road tests, with comments. 800 w. R R Gaz—June 14, 1901. No. 41645.

What Is the Most Promising Direction in Which to Effect a Reduction in Locomotive Fuel Consumption. Report of the committee concerning methods worthy of consideration. 5700 w. Am Mas Mech Assn—Saratoga meeting, 1901. No. 41-620 C.

Glasgow.

Glasgow's Tramway System. A. C.

Shaw. Reviews the history of Glasgow's tramways, and gives an illustrated detailed description of the recently installed electrical equipment. 9000 w. St Ry Jour—June 1, 1901. No. 41412 D.

The Glasgow Corporation Electric Tramways. An illustrated account, giving a summary of the principal facts in regard to the station and equipment. 4500 w. Tram & Ry Wld—May 9, 1901. No. 41351 B.

Grate Areas.

Grate Areas for Burning Culm. T. S. Lloyd. Gives table of fuel tests, and discusses the practice on the D. L. & W. R. R. 1500 w. Am Engr & R R Jour—June, 1901. No. 41445 C.

Locomotive Driving.

The Question of Alternating Locomotive Engineers (Zur Frage des Wirthschaftlichen Nutzens der Doppelbesetzung der Lokomotiven). M. Herrmann. An examination of the advantages of alternating engineers for locomotives in place of leaving the engine to a single operation. 3000 w. Glaser's Annalen—June 1, 1901. No. 41726 D.

Locomotive Fuel.

Burning Crude Oil in Locomotives. From the discussion of W. N. Best, at the last meeting of the Pacific Coast Ry. Club. Considers types of burners, means of securing perfect combustion, etc. 2000 w. R R Gaz—June 21, 1901. No. 41819.

Locomotives.

American Locomotives in England. Charles Rous-Marten. An article in defense of the American engines, and showing the injustice of the comparison recently made with British engines. 3000 w. Engr, Lond—June 14, 1901. No. 41839 A.

An Improved Cast Steel Locomotive Frame. Robert M. Galbreath. Also editorial. A statement of the several features of the steel frame question, with illustrated description of design and record of wear of driving boxes. 3000 w. R R Gaz—June 14, 1901. No. 41648.

C. B. & Q. Inspection Locomotive. Illustrated description. 600 w. Ry & Engng Rev—June 8, 1901. No. 41551.

Erie Class H-12 Consolidation Locomotive. Illustrated detailed description. 800 w. R R Gaz—June 14, 1901. No. 41644.

European Railway Jottings. Illustrated descriptions of a small tank engine used about the year 1850, and two of the latest arrivals among the British express engines. 3000 w. Loc Engng—June, 1901. No. 41431 C.

Express Engine, London, Brighton, and South Coast Railway. Illustration and principal dimensions with remarks. 1000 w. Engr, Lond—June 7, 1901. No. 41615 A.

Intercolonial Locomotives With Cleveland Cylinders. Illustrated description of one of the passenger engines, recently ordered from the Dickson Locomotive Works. 1700 w. R R Gaz—June 14, 1901. No. 41642.

Italian Express Locomotive. Illustrates details of this high-speed compound locomotive giving dimensions. 800 w. Engng—June 14, 1901. No. 41835 A.

Locomotive Progress. Annual review of changes in design and progress in construction. 1400 w. Ry Mas Mech—June, 1901. No. 41315.

New Type of Freight Locomotives for the Chicago, Burlington & Quincy R. R. Illustrates and describes the new "Prairie" type of engines under construction for this road. 1700 w. Eng News—May 30, 1901. No. 41307.

Richmond Locomotives for Finland. Illustrated description of the ten-wheel locomotives for the State Railways. 800 w. Ry Age—May 31, 1901. No. 41421.

Six-Coupled Compound Express Engine, Mediterranean Railway of Italy. Dimensions and some constructional details of this engine. 3700 w. Engr, Lond—May 31, 1901. No. 41495 A.

The "De Glehn" Compounds on the Northern of France. R. Hope. Records of the actual performances of these engines, with remarks. 2700 w. R R Gaz—June 7, 1901. No. 41535.

Vanderbilt Locomotive and Tender—Illinois Central Railroad. Illustrated description of a ten-wheel freight locomotive on exhibition at the Pan-American Exposition, which is attracting much attention. 1200 w. R R Gaz—May 31, 1901. No. 41313.

Wide Firebox Locomotives. An illustrated account of the development in the direction of increased grate surface. 4300 w. Ry Age—June 14, 1901. No. 41660.

Los Angeles.

Recent Work of the Los Angeles Railway. Illustrates and describes features of interest. 2000 w. St Ry Jour—June 1, 1901. No. 41413 D.

Mileage.

Should Engine Ton Mileage Be Included in Motive Power Statistics? C. H. Quereau. Discusses this question at some length. 4000 w. Am Engr & R R Jour—June, 1901. No. 41446 C.

Old Cars.

Method of Utilizing Old Street Cars. Illustrated descriptions of old cars utilized as dwellings and an account of quite a settlement formed in this way at the seaside in California. 900 w. Sci Am—June 29, 1901. No. 41864.

Oil Fuel.

Oil Burning on Locomotives. Extracts from answers to questions bearing on this subject presented before the Pacific Coast

Ry. Club. 2800 w. Ry & Engng Rev—June 15, 1901. No. 41663.

Private Car.

A Unique Private Car. Illustrated description of a car built for the general manager of the Union Traction Co., of Indiana. It is an office and home on wheels. 500 w. Ry Age—June 14, 1901. No. 41659.

Power House Design.

The Steam Features of Electrical Power House Design. F. W. Dean. Considers the boiler plant and the use of water-tube boilers, and things of importance to secure economy; the choice of engines, the steam pipes, and related equipments. 4600 w. R R Gaz—June 14, 1901. No. 41652.

Rolling Stock.

Rhodesian Railway Rolling-Stock. Illustrated description of the *train de luxe* for this road. 900 w. Engng—May 31, 1901. Serial. 1st part. No. 41502 A.

Sheffield, Eng.

The Equipment of the Sheffield Electric Tramway System. A. L. C. Fell. Read before the Northern & Midland Co.'s Assn. Illustrates and describes points of interest in the equipment. 2700 w. Tram & Ry Wld—May 9, 1901. No. 41352 B.

Shop Equipment.

Power Equipments for Railroad Shops. George A. Damon. A consideration of the important things to examine before reaching a conclusion in the problem of supplying a modern railroad shop with an up-to-date power equipment. Ill. 3300 w. R R Gaz—June 21, 1901. Serial. 1st part. No. 41818.

Steel Axles.

The Chemical Composition of Steel Freight Axles. William Forsyth. Remarks showing that the steel manufacturers favor an axle steel which is higher in carbon than the present M. C. B. limits. 700 w. R R Gaz—June 14, 1901. No. 41653.

The Chemistry and Manufacture of Steel Axles. C. E. Middleton. Considers the chemical composition and the improved methods of manufacture which have greatly reduced the sources of trouble. 1300 w. R R Gaz—June 14, 1901. No. 41641.

St. Helen's.

St. Helen's Electrical Tramways. Illustrated description of one of the first lines in England to adopt electricity. 2300 w. Tram & Ry Wld—May 9, 1901. No. 41-350 B.

Test Car.

Railway Test Car No. 17, Univ. of Illinois and Ill. Cent. R. R. Edward C. Schmidt. Illustrations and account of the performance of this test car during its nine months of service. 1300 w. Ry. & Engng Rev—June 1, 1901. No. 41410.

Trucks.

Rigid vs. Swing Center Car Trucks. F. P. Roesch. The writer explains and proves his theory that the rigid cars pull harder, weight for weight, than the swing-truck and loose drawbar car. 1600 w. Loc Engng—June, 1901. No. 41432 C.

Water Treatment.

Some Phases of the Water Treatment Problem. Howard Stillman. A study of the treatment of water for locomotive use only. 1600 w. Am Engr & R R Jour—June, 1901. No. 41443 C.

NEW PROJECTS.

Abyssinia.

The Railway from Djibonti to Harrar (Le Chemin de Fer de Djibonti au Harrar). A. Dumas. A description of the railway now under construction from Djibonti on the Gulf of Aden to Harrar and to Addis-Abeba, the capital of Abyssinia. 3500 w. 1 plate. Génie Civil—May 25, 1901. No. 41704 D.

Africa.

The Kumasi Railway. Information and illustrations of this road under construction. 800 w. Engng—May 31, 1901. No. 41499 A.

Connecting Line.

The Liske and Looe Railway. An account of a line just opened, joining this line with the Great Western Railway. 1200 w. Transport—June 7, 1901. No. 41-624 A.

Incline.

The Montmartre Inclined Railway. From *La Nature*. Illustrated description of a railway in Paris constructed to save people the tiresome climb of 220 steps necessary to reach the cathedral. 1000 w. Sci Am Sup—June 1, 1901. No. 41289.

Japan.

Railways in Japan. Information concerning the railway situation at the end of 1899. 600 w. U S Cons Repts, No. 1057—June 8, 1901. No. 41374 D.

Mono-rail.

The Manchester and Liverpool Express Railway. Editorial discussion of the proposed thirty-five mile line on the mono-rail system, which is to cover the distance in twenty minutes. 1500 w. Engr, Lond—May 24, 1901. No. 41363 A.

Monorail.

The Monorail Railway. Editorial discussion of the scheme to construct a monorail railway between Liverpool and Manchester. 3000 w. Engng—May 31, 1901. No. 41503 A.

Tasmania.

The Great Western Railway of Tasmania. An account of the proposed construction of a railway for the development of a portion of this island. Map. 2000 w. Transport—May 29, 1901. No. 41347 A.

PERMANENT WAY AND FIXTURES.

Culverts.

The Design of Arch Culverts. Daniel B. Luten. Illustrates and describes the standard designs adopted by most American railways and presents the advantages of the flat arch. 1400 w. Eng News—June 13, 1901. No. 41581.

Curves.

Holbrook's Spiral Curves. E. Holbrook. An explanation of the actual work in the field, giving tables and figures. 1700 w. Eng News—June 13, 1901. No. 41580.

Elevator.

Hydraulic Elevator for Railway Carriages. (Ancenseur Hydraulique pour Wagons.) Illustrated description of new hydraulic lift at the Rome-Trastevere station of the Mediterranean Railway of Italy. 800 w. 1 plate. Génie Civil—May 18, 1901. No. 41701 D.

Java.

Some Difficulties with the Railways of Java (En Zijne Bemoeiingen met de Spoorwegen op Java). J. P. de Bordes. A review of the work upon the railway of Java and the difficulties encountered in their construction by the late chief engineer. 10000 w. Tidschr v h Kljk Inst van Ing—Feb. 9, 1901. No. 41763 H.

Rail-Bonds.

Concerning Rail-Bonds. Samuel Sheldon. Outlines the common methods employed, and remarks on the importance of perfect work and frequent inspection. 1400 w. St Ry Jour—June 1, 1901. No. 41415 D.

Return Cables vs. Rail Bonding. Alton D. Adams. Discusses these two systems showing the bonded system cheaper in first cost, but so much more expensive in maintenance as to make it soon exceed the cable system. 2400 w. Marine Engng—June, 1901. No. 41399 C.

Rail Joint.

The Bochum Rail Joint (Bochumer Schienenstoss-Verbindung). J. Grimme. Describing and illustrating a form of bridge rail joint especially adapted for tramway service. 1000 w. Schweizerische Bauzeitung—May 11, 1901. No. 41756 B.

Roundhouse.

An Up to-Date Roundhouse. Report of the committee of the American Railway Master Mechanics' Association. Ill. 3000 w. Am Mas Mech Assn—Saratoga meeting, 1901. No. 41619 C.

Shop.

Sandou Engine Works. An illustrated description of the new erecting shop and its equipment. 3000 w. Engr, Lond—June 14, 1901. No. 41841 A.

Shop Extensions.

Topeka Shop Extensions. R. P. C. Sanderson. Illustrated account of extensive shop improvements on the A., T. & St. F. Ry. 3000 w. Am Engr & R R Jour—June, 1901. No. 41440 C.

Station.

A New Passenger Station in Chicago. Illustrated description of the accepted plans for a station at Van Buren street. 1600 w. Ry Age—June 14, 1901. No. 41658.

Artistic Suburban Stations. Illustrates examples in the vicinity of Chicago. 600 w. Ry Age—June 14, 1901. No. 41661.

Pittsburgh & Lake Erie Station at Pittsburgh. Illustrates and describes one of the finest passenger stations in the United States. 1200 w. R R Gaz—June 7, 1901. No. 41536.

The Sullivan Square Station, Boston. Illustrated description of a double-deck train shed at one of the terminals of the Boston Elevated Ry., and of a large number of electric railways. The roof arches have a span of 175 ft. 1700 w. Eng Rec—June 15, 1901. No. 41563.

Steel Rails.

Specifications for Steel Rails. Continued discussion of Mr. Webster's paper. 2400 w. Trans Am Inst of Mine Engrs—June, 1901. No. 41680 D.

Switch.

The Vaughan Split Switch. Illustrated detailed description of this design. 700 w. Ry & Engng Rev—June 22, 1901. No. 41848.

Ties.

The Making of Railroad Ties. Aloysius Coll. Information in regard to the cutting and preparation of the ties, their transportation, etc. 2200 w. Am Mfr—May 30, 1901. No. 41297.

Track Tanks.

The Feeding of Locomotives in Motion (Alimentation des Locomotives en Marche). A general review of the devices for taking up feed water for locomotives from tanks between the rails, with details of the methods used on the French railways. 2000 w. 1 plate. Génie Civil—June 8, 1901. No. 41708 D.

Uganda.

Physical and Economic Features of the Uganda Railway. F. W. Emett. A fully illustrated account of this forerunner of civilization and traffic into the heart of Africa. 3500 w. Engineering Magazine—July, 1901. No. 41775 B.

Unloaders.

Automatic Unloaders (Selbstentlader). M. Buhle. Illustrating and describing various forms of cars for tipping and dumping earth, including both American and German designs. 2000 w. Zeitschr d Ver Deutscher Ing—May 25, 1901. No. 41713 D.

TRAFFIC.

Coal Consumption.

Locomotive Coal Consumption. M. N. Forney. Brief discussion of the available sources of economy in fuel consumption. 1200 w. Am Engr & R R Jour—June, 1901. No. 41439 C.

Engine Rating.

The Basis of Engine Rating. J. Shirley Eaton. Discusses methods of tonnage rating. 2800 w. R R Gaz—June 14, 1901. No. 41643.

Exposition Crowds.

Handling Pan-American Exposition Crowds on the Buffalo Railway. Illustrates and describes the arrangements made for the transportation and control of large crowds. 900 w. St Ry Jour—June 1, 1901. No. 41417 D.

Heavy Service.

Best Type of Engine for Heavy Fast Passenger Service. F. F. Gaines. Discusses the best type as regards wheel base arrangements. Ill. 1200 w. Am Engr & R R Jour—June, 1901. No. 41444 C.

Electricity v. Steam for Heavy Railway Service. L. D. Tandy. A comparison of lines in operation in the United States, showing the advantages over steam and the saving in operating expenses. Ill. 5000 w. Tram & Ry Wld—May 9, 1901. No. 41349 B.

Prussia.

The Development of the Railways of Prussia from 1890 to 1900 (Die Enturckelung des Eisenbahnwesens in Preussen 1890 bis 1900). Statistical data from the report of the Department of Public Works. 1800 w. Glückauf—May 18, 1901. No. 41731 B.

Tonnage Rating.

Practical Tonnage Rating. George R. Henderson. Presents rules and diagrams by the use of which the writer believes it will be possible to rate almost any modern engine on any profile and alignment, and with very few calculations to establish a satisfactory schedule. 3500 w. Am Mas Mechs' Assn—Saratoga meeting, 1901. No. 41622 C.

MISCELLANY.

Electrolysis.

See Civil Engineering, Water Supply.

Statistics.

The Railroads of the World. Tabulated information compiled and reduced from statistics published in the *Archiv für Eisenbahnwesen,* with editorial. 2000 w. R R Gaz—May 31, 1901. No. 41310.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* JOHN R. DUNLAP, PUBLISHER.

Coal Mining.

Elementary Text Book of Coal Mining. By Robert Peel. Pp. 300. Price $1.00. London: Blackie & Son. Philadelphia: J. B. Lippincott Co.

A text book for the classes in coal mining of the Science and Art Department, also forming a convenient handbook for those attending lectures upon mining. The book gives much general information upon the subject of coal mining, but is confined mainly to British practice and methods.

Electricity.

Alternating Currents. An Analytical and Graphical Treatment for Students and Engineers. By Frederick Bedell and Albert C. Crehore. Size 6 in. by 9 in.; pp. 325. Price $2.50. New York: *Electrical World and Engineer.*

The fourth edition of Bedell and Crehore's well-known work. Part I contains the analytical treatment, discussing circuits containing resistance, self-induction and capacity, with the solution of problems. Part II discusses the same problems graphically, while appendices containing electrical units, and mechanical and electrical analogies, are added.

Marine Engineering.

Practical Advice for Marine Engineers. By Charles W. Roberts. Pp. 150. Price 75 cents. London: Whittaker & Co.; New York: The Macmillan Co.

A practical handbook, especially intended for junior engineers, desirous of advancing themselves by acquiring a thorough knowledge of marine engineering.

Oil Engines.

The Design and Construction of Oil Engines. With Full Directions for Erecting, Testing, Installing, Running, and Repairing. By A. H. Goldingham, M. E. Price $2.00, 7s. 6d. Size 5 by 7½ in.; pp. 196. New York: Spon & Chamberlain; London: E. & F. N. Spon, Ltd.

The book, as its title suggests, is intended for draughtsmen, oil-engine attendants, or those owning or about to install oil engines, its purpose being to supply sufficient knowledge of principles to insure intelligent practical work. The treatment of vaporization, ignition, and valve mechanism is just full enough to make clear the much fuller following chapters on designing, testing, and running oil engines for varied service. A brief description of each of the principal types of oil engines is given.

Roads.

Road Making and Maintenance. A Practical Treatise for Engineers, Surveyors, and Others. By Thomas Aitken. Pp. 440. Price $6.00. London: Charles Griffin & Co.; Philadelphia: J. B. Lippincott Co.

A comprehensive treatise from the quarrying of the material to the completion and maintenance of the road. The question of crowded city traffic is discussed and a large portion of the book is devoted to the construction of carriage-ways and footpaths.

Rivers.

Profiles of Rivers in the United States. By Henry Gannett. Size 6 by 9 in.; pp. 100. With map and 11 plates of river profiles. U. S. Geological Survey, Washington, D. C., U. S. A.

No. 44 of the series of Water-Supply and Irrigation papers. A very important publication. The profiles are given in tabular form in the body of the paper, each prefixed by a general description of the river and citation of the authority for the figures presented. In the plates, the profiles are represented graphically on a uniform scale. A discriminating introductory discussion calls attention to the varying accuracy of the various sources of information from which the data are drawn.

Sea-Beach.

The Sea-Beach at Ebb Tide. By Augusta Foote Arnold. Size, 5½ by 8 in.; pp. 490. Ill., 600. Price, $2.40 net, $.20 postage. New York: The Century Company.

An excellent working manual for the identification, preliminary study, and collection of the animal and vegetable forms found on the coasts of the United States. It is addressed to those who are intelligently or even casually interested in the seaweeds, polyps, sponges, shells, crustaceans, and other types of life of the beaches and tide-pools. Without presupposing any technical study on the reader's part, it is soundly scientific in arrangement and method. Its plain language and copious illustration make it thoroughly serviceable to the amateur, while its orderly arrangement gives a true idea of the relation and systematic grouping of the species described. A satisfactory and valuable hand-book of reference for the seaside.

Steam Engineering.

An Elementary Text Book of Steam Engines and Boilers. By J. H. Kinealy, Professor of Mechanical Engineering at Washington University. Price, $2.00, 7s. 6d. Size, 6 by 9 in.; pp. 259. Third edition. New York: Spon & Chamberlain; London: E. & F. N. Spon, Ltd.

Professor Kinealy's text book has been revised, corrected, and in part rewritten for this edition. It deals with the subject entirely from the theoretical side, treating of elementary thermodynamics, the theory of the steam engine, types of engine, admission of steam by valves, valve diagrams and indicator cards, compounding and condensing, combustion of fuel, types of boilers, etc., in the manner of an authoritative text book for students.

Steam Engineering.

How to Run Engines and Boilers. With a New Section on Water-Tube Boilers. By Egbert Pomeroy Watson. Fifth edition. Price $1.00, 4s. Size, 4¼ by 6½ in.; pp. 160. New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd.

A revision of the fourth edition of this excellent little manual of "practical instruction for young engineers and steam users." It accomplishes admirably its purpose—to give the inexperienced a clear, comprehensive statement of the first principles and practical rules of management and maintenance of the boiler and engine. It is treated from the standpoint of the man in practical charge of the steam plant, with enough explanation of theory to make clear the reasons for the rules of practice.

Stream Gaugings.

Operations at River Stations, 1900. A Report of the Divisions of Hydrography of the U. S. Geological Survey. Part I. Size, 6 by 9 in.; pp. 99. U. S. Geological Survey, Washington, D. C., U. S. A.

Pamphlet No. 47 in the series of Water-Supply and Irrigation papers, giving descriptions of the river stations maintained by the U. S. Geological Survey, with details of average daily height of water and measurements of discharge, affording very valuable assistance for the estimation of available power on the larger streams of the United States. The tabulated measurements, arranged by States, are prefaced by sections on the use of stream gaugings for computation of water power, on the measurement of sediment, and a most interesting one on tests of the accuracy of discharge measurements as made in the N. Y. State canal surveys by Mr. E. Kuichling and Professor G. S. Williams. The law limiting these papers to 100 pages each has compelled division of the material. The pamphlet in hand is devoted to New England and Eastern streams. Succeeding papers take up rivers flowing into the Atlantic Ocean, those of the Ohio and Mississippi valleys, the Great Lakes, Missouri and Rio Grande, interior basin, Pacific, and Southern California.

Telephony.

ABC of the Telephone. By James E. Homans, A. M. Price, $1.00. Size, 5 by 7½ in.; pp. 335. New York: Theo. Audel & Co.

An elementary and general treatise, designed particularly for the student and worker in telephony and for laying the foundations for specialized technical study of the subject. The language is adapted to the non-professional reader; the treatment is largely descriptive of apparatus and practice. Six chapters deal with history and general principles; Chapter VII discusses the transmitter; Chapter VIII, the circuits of the apparatus; Chapter IX to XV, switches and switchboards; Chapter XVI to XX, line systems and signals; Chapters XXI to XXVI, line and cable construction and protection; Chapters XXVII and XXVIII, miscellany.

Wages.

Les Salaires dans l' Industrie Gantoise. I. Industrie Cotonnière. Par Louis Varlez. Size 6 in. by 9in.; pp. 590. Price 8 francs. Bruxelles: S. Lebègue et Cie.

The first volume of an exhaustive study of the wages of operatives in the various industries of Ghent. The volume is a portion of an official inquiry into industrial conditions, and is devoted to the cotton industry, including history, hours of labor, rates of wages at various periods, comparisons with other countries, etc., with numerous diagrams and tables.

Water Flow.

New Tables for the Complete Solution of Ganguillet's and Kutter's Formula for the Flow of Liquid in Open Channels, Pipes, Sewers, and Conduits. By Col. E. C. S. Moore, R. E. Size, 6 in. by 9 in.; pp. 231. Price, 15 shillings. London: B. T. Batsford.

A very elaborate set of tables giving values of the coefficients for 1,080 inclinations, ranging from 1 over 1, to 1 over 21,150 for 15 different values of the coefficient of roughness n. These tables will save an immense amount of computation for hydraulic engineers, and cover almost all conditions occurring in actual practice.

THE WORLD IS ITS FIELD.
THE ENGINEERING MAGAZINE

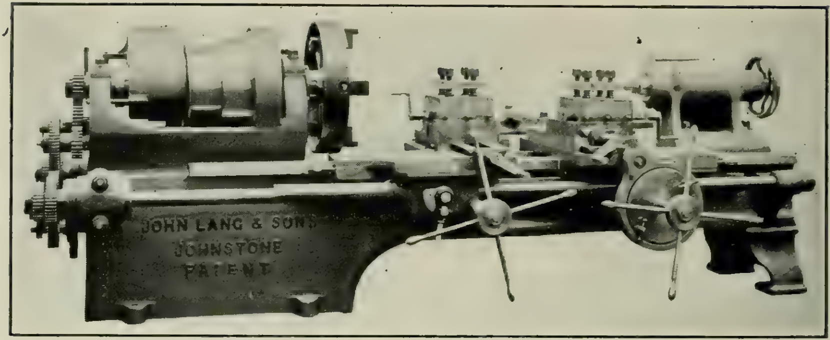
VOL. XXI. SEPTEMBER, 1901. No. 6.

ENGINEERING AT THE GLASGOW EXHIBITION.

By John G. Kerr, LL. D.

The exposition was doubtless first conceived as an effective instrumentality for influencing the buyer; it has taken on a new and almost a greater importance as an agency for broadening and bettering the practice of the manufacturer, by display of the best methods and products throughout all industry. This is even more apparent since the spread of internationalism in trade exchanges and trade competition. In this light, as concrete manifestations of the leading tendencies in applied engineering, we treat this month of the great expositions now open in the two great Anglo-Saxon industrial nations.—THE EDITORS.

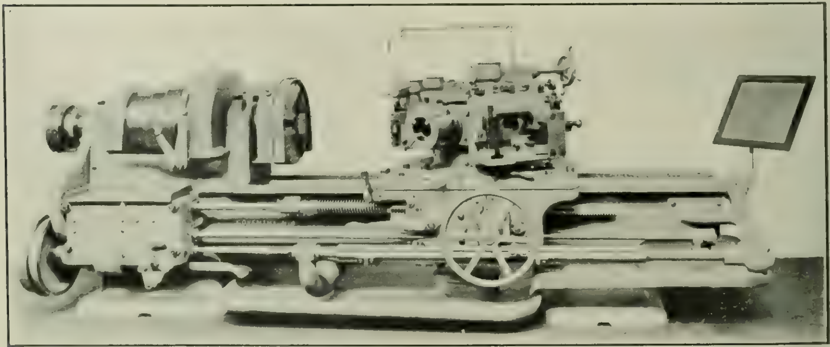
GLASGOW, in virtue merely of its extensive and varied manufactures, its engineering shops and ship-building yards, may fairly be looked upon as one of the great centres of engineering enterprise in Britain. But we may go further and, with some show of reason, claim that the city of Black, Watt, Macquorn Rankine, and the Thomsons (Lord Kelvin and his distinguished brother) has in no casual way functioned as an active originating centre of engineering progress to the world at large. Not to the great researches and speculations associated with these names only does applied science confess her debt. No truly great man is without disciples, and from the lecture rooms and laboratories of the ancient University of Glasgow there have passed out into the work-a-day world many capable and enthusiastic students, who in process of time took rank as eminent physicists and engineers. It is fitting, therefore, that we should look for and find in the Exhibition opened in this city on May 2d, many and splendid



LATHE FOR TURNING SHELLS. JOHN LANG & SONS.
The saddle nearest the headstock forms the cylindrical part, while the other, with a radius-bar attachment, cuts the tapering nose.

evidences of the high degree of perfection which has been attained in all branches of mechanical science.

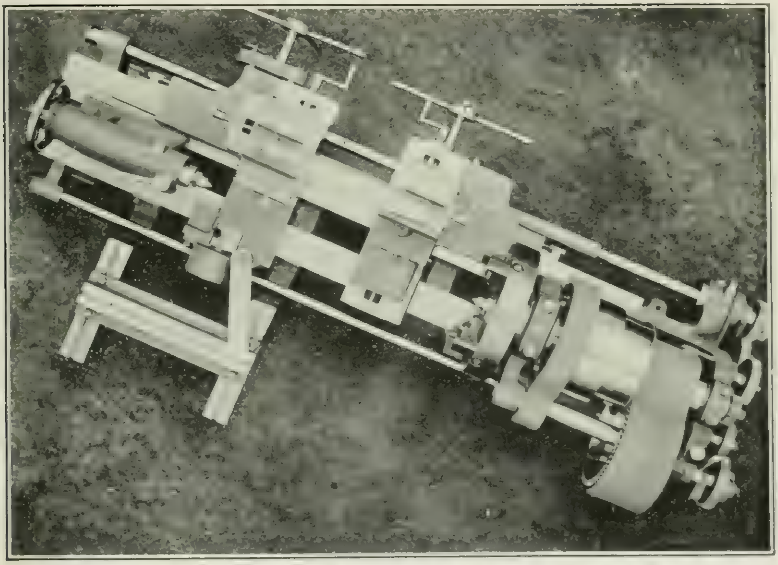
It is true, no doubt, that the extent of the Exhibition falls short of the marvellous display within the white palaces of the World's Fair at Chicago in 1893 and also that magnificent collection accommodated at Vincennes in the Paris Exhibition of last year. Yet what is lacking in amplitude is, I venture to say, compensated for by the representative character of the exhibits. From the international standpoint one could desire a more extensive representation. In explanation of shortcomings in this direction we may point to the fact that in all countries now demands are being made for rapid delivery of productions, and machinery cannot readily be dispensed with for the long period during which the Exhibition is opened. This is particularly true of the department which comprehensively is spoken of as Transport. Accordingly we find in such exhibits as railway locomotives a great falling off



NO. 4 PATENT HEXAGON TURRET LATHE, EXHIBITED BY ALFRED HERBERT, LTD., COVENTRY.

from that imposing array which formed outstanding sections at Chicago and at Paris. And we regret this the more as the subject of locomotive engineering and British practice occupies so much attention.

With machine tools, on the other hand, there is a very full demonstration, not only of American practice, which is finding such extensive support in Britain, but also of German tools; and at the same time it is made obvious by this exhibit that, however much British tool-makers may have lagged behind the Americans in appreciating the suitability and economy of automatic screw-cutting and capstan lathes, they are rapidly making up lee-way, and in some instances if not improving upon, they are at any rate seriously emulating their Trans-Atlantic instructors. Indeed, of some six hundred exhibitors who have stands in the large machinery hall, a very considerable proportion, say one-fifth, belong to this department, while in the series of pavilions lining the northwest upper avenue, familiarly spoken of as "Machinery Street," many additional machine-tool-making firms show their specialties. The largest capstan lathe in the Exhibition is by a British maker, Herbert of Coventry. It is of the hexagonal-turret type with special stop and feed motions and can deal with bars up to 3½-inches diameter. Messrs. Lang of Johnstone have several interesting novelties; among these a fine centering machine deserves attention. Their lathe for shells is well worth looking at. One saddle, that nearest the

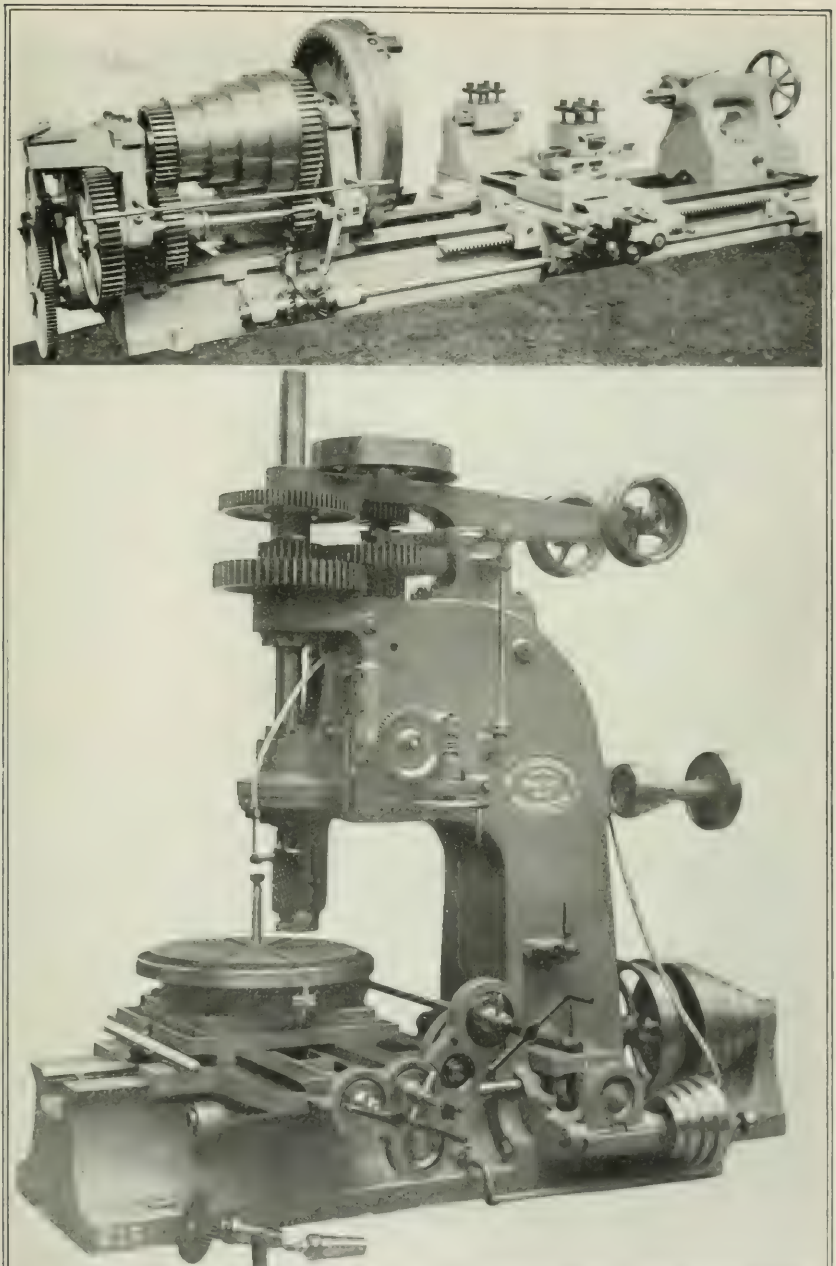


JOHN LANG & SONS' SHELL TURNING LATHE. TOP VIEW.

headstock, forms the cylindrical portion of the projectile while the curved nose is formed by another with a radius bar attachment. Reference may also be made to a surfacing and boring tool with a 30-inch swing and so geared that by a simple motion of a handle the feed may range in six steps from 4 to 160 cuts per inch. Messrs. P. & W. Maclellan, of Glasgow, shew a lathe in which the headstock is given a swivelling motion to turn, without resetting, the concave end of a railway-wagon buffer. Messrs. Smith & Coventry have also a new turret lathe which combines the open-spindle bolt-machine system with the flat-turret arrangement. Messrs. Sharp, Stewart & Co. have an ingenious 10-inch capstan lathe, and the machine with its tools and tool-holders exhibited by the Jones and Lamson Machine Company repays inspection. It is hardly necessary here to deal with American tools, yet attention may be directed to a machine by the Bridgeport Automatic Machine Company for automatically cutting screw threads. The saddle travels to and fro along the lathe bed, the cutting tool being fed into its cut until the correct size has been reached. This tool is exhibited at the stand of Messrs. Selig Sonnenthal & Co., where also will be found a lathe with a special feed-change mechanism produced by the Hamilton Machine-Tool Co. of Ohio.

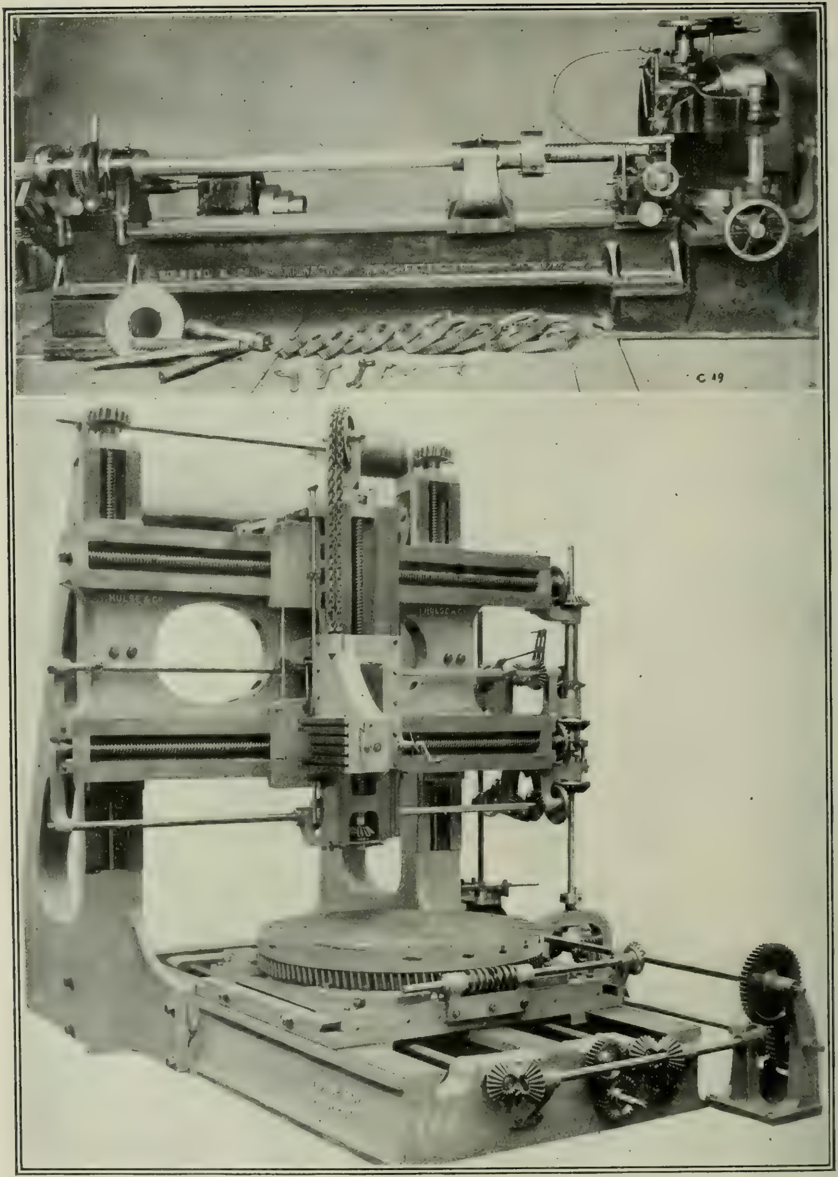
Most interest will no doubt be taken, particularly by foreign visitors, in the exhibit of large tools, for here at any rate Britain is not obviously behind her rivals, even although several large British engineering works possess American tools of this class. All the large makers are exhibiting. Messrs. Shanks, of Johnstone, have a particularly interesting stand shewing lathes, screwing, and turning machines, as well as the larger planing and slotting tools. Their 3-foot diameter grindstone is interesting on account of the protection afforded by the large, slightly concave, circular plates which are bolted on the square shaft carrying the stone, and which grip the latter on either side near its periphery. Of the many notable examples of large tools shewn by British makers we may direct attention to the exhibits of Messrs. Hetherington of Manchester, Sharp, Stewart & Co. of Glasgow, Hulse of Salford, and Holyroyd & Co., Manchester.

One feature of the Exhibition is the evidence it offers of the extent to which electricity is being applied in engineering, and it is obvious that with the rapid growth throughout Britain of large power stations further developments may be looked for. As instances of this application we have on the one hand small brass-finishers' tools driven with quarter-horse-power motors, and on the other large electrically driven pumps such as exhibited by Evans & Sons, Wolverhampton, or by the



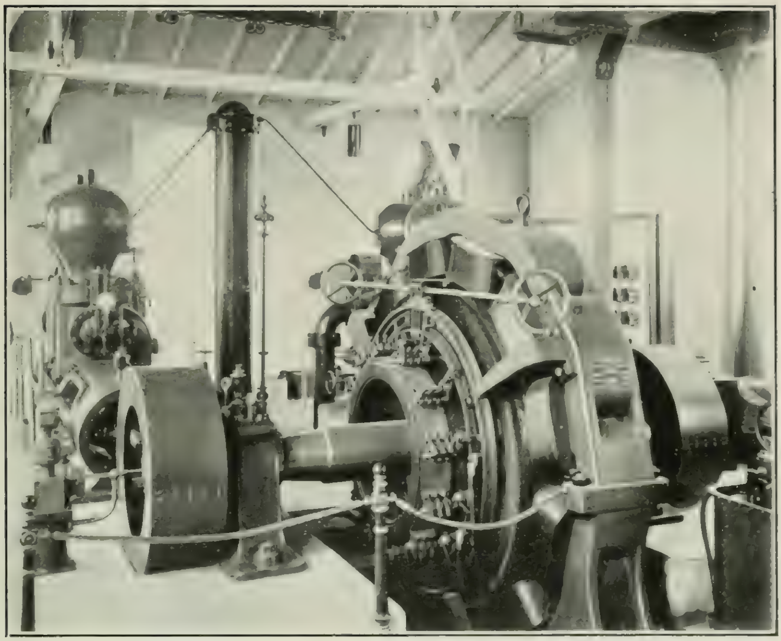
TYPICAL BRITISH HEAVY TOOLS IN THE GLASGOW EXHIBITION.

The upper machine is a 27-inch triple-geared surfacing and screw-cutting lathe with duplex rests, by Sharp, Stewart & Co., Ltd., Glasgow; for propeller shafts, gun tubes, or general work. The lower tool is a vertical milling and drilling machine by John Hetherington & Sons, Ltd., Manchester. It weighs about 15,700 lb., and the distance from spindle to upright is 2 ft. 3 in.

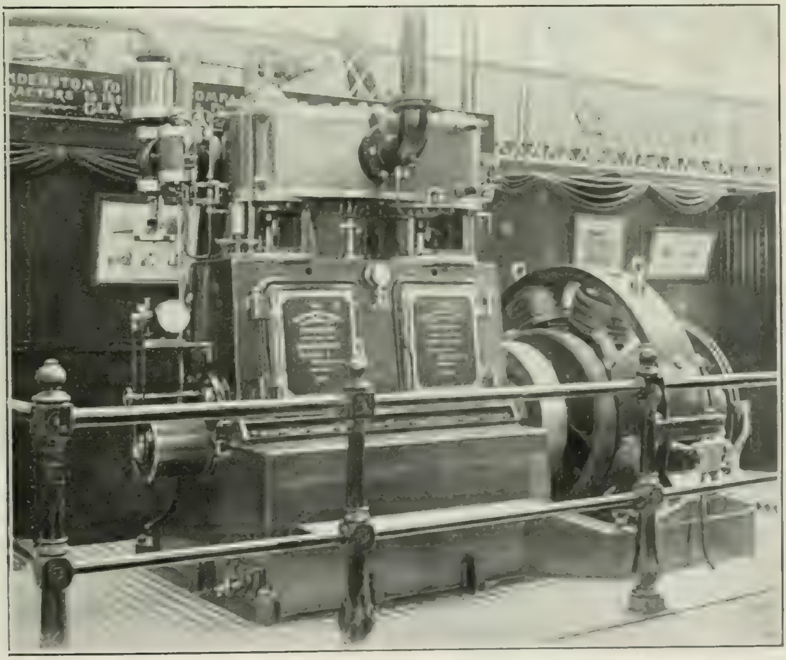


TYPICAL BRITISH HEAVY TOOLS IN THE GLASGOW EXHIBITION.

The upper cut is a screw milling machine, right or left-hand, by John Holroyd & Co., Manchester. Mills any length of screw-thread, square or other section, between the limits of 1 in. and 2½ in. diameter, also threads of worms or screws not exceeding 5 in. diameter and 4 ft. length, whilst pitch may be varied from ⅙ in. to 2 in. Below is a special combined planing and slotting machine by Hulse & Co., Salford, Manchester, for planing cylinders, framing, etc., or slotting cranks of stationary or marine engines. Weighs 45 tons. Planes 9 ft. horizontally or 4 ft. vertically.

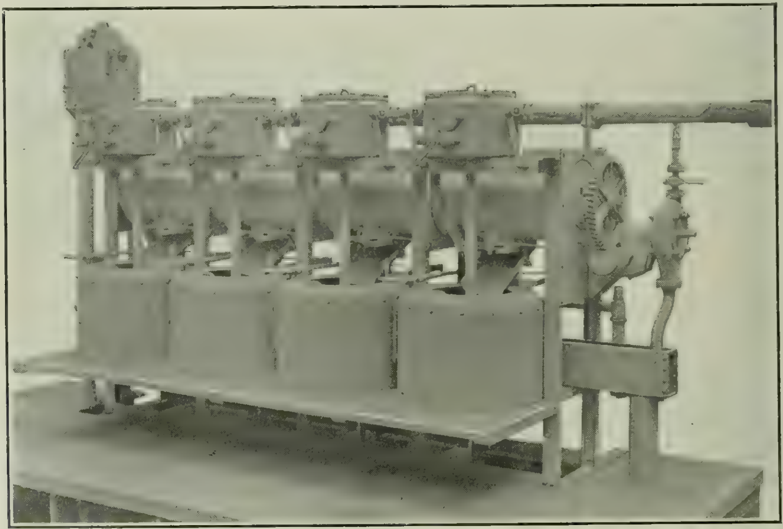


ELECTRICALLY DRIVEN PUMP SET. DRIVING END.
Exhibited by the British Shuckert Electric Co., Ltd., London.

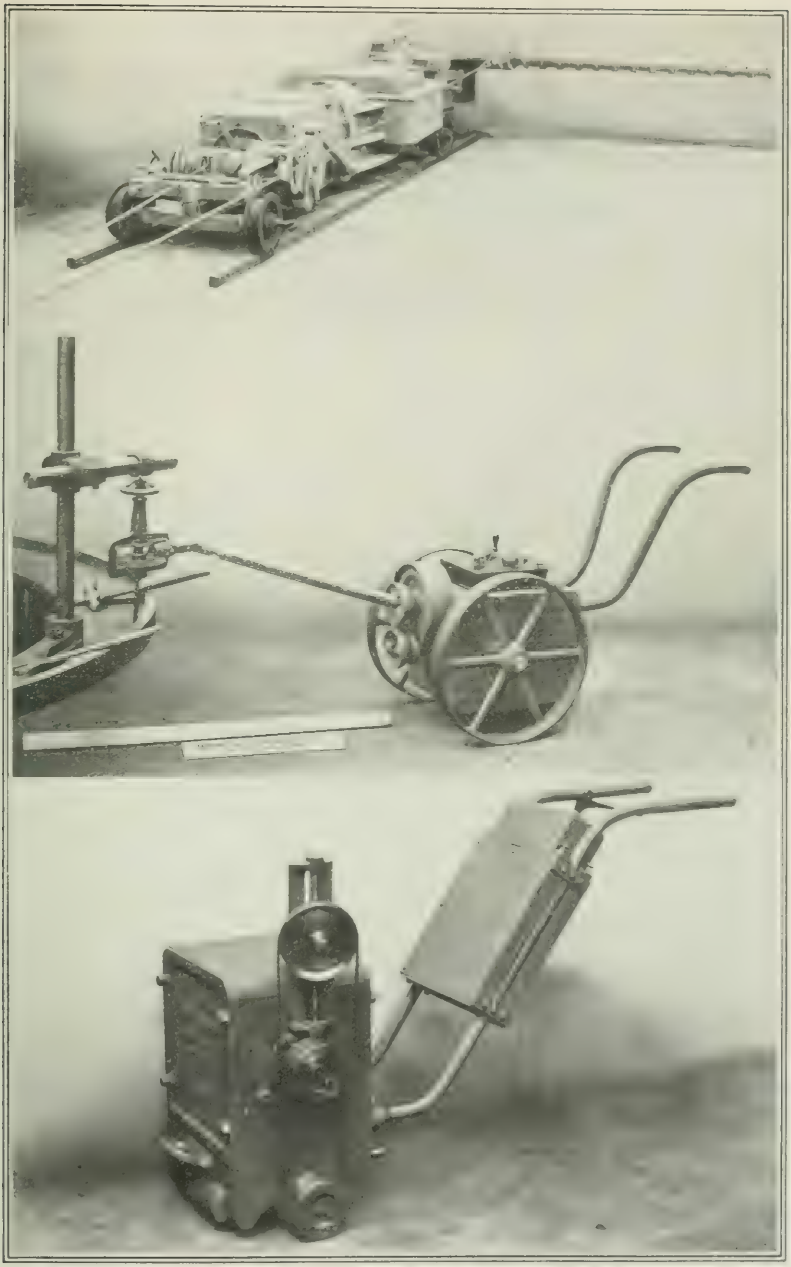


ENGINE AND DYNAMO SET, ANDERSTON FOUNDRY CO., GLASGOW.

Schukert Company. For centrifugals electricity seems specially available, the motor being applied either at the top of the spindle or under the pan. It should be remarked however that water power where it is available usually actuates centrifugals. Thus the Watson Laidlaw Company have adopted for this purpose the Pelton wheel, mounting it on the top of the spindle. Control of acceleration from the start right up to maximum speed is of consequence, on account of the differences in behaviour of various grades of sugar under the influence of the centrifugal, and this control is secured by means of a clever system of valves. We have with high-grade sugar a velocity of 850 revolutions attained in 45 seconds, whereas with fine-grained sugar it is desirable that this speed should not be attained until after, say, 3 minutes from the initial movement. The number of cases in which the motor may be spoken of as an integral part of the machine it drives is not very large. There are, however, several air compressors in which the motor is coupled direct to the shaft which actuates the compressor piston. Messrs. Mavor & Coulson of Glasgow shew several appliances, notably a deck-planing machine, a portable electric drill, and a coal-cutting machine in which the motor is really a part of the instrument. The motor of the deck-planing machine is 3-horse-power and makes some 3,000 revolutions per minute, the cutting knives attaining the same velocity. The expedition and economy with which this machine deals with ships' decks have secured its wide use in Germany and America

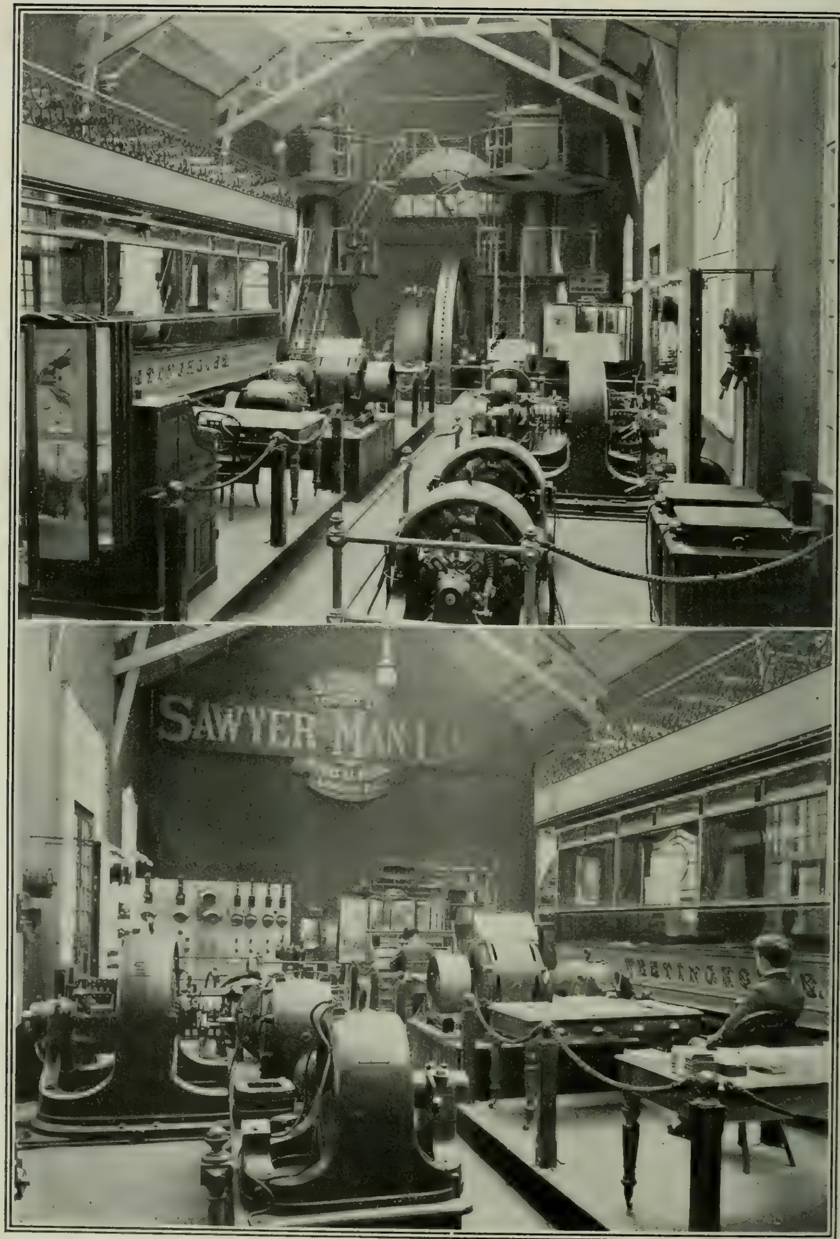


FOUR 30-INCH WATER-DRIVEN "WESTON" CENTRIFUGALS.
By Watson, Laidlaw & Co., Glasgow.



A GROUP OF ELECTRIC-DRIVEN TOOLS. MAVOR & COULSON, LTD., GLASGOW.

At the top is the coal-cutter, medium-size, for 4 ft. 6 in. undercut. Speed 400 r. p. m. Next is the portable drill, driving through telescopic or flexible shaft and adaptable (in three sizes) for drilling holes from ½ to 2 inches diameter, or for emery-wheel work. At the bottom is the deck planer, with 3 horse-power motor.



TWO VIEWS IN THE INTERIOR OF THE WESTINGHOUSE PAVILION AT THE GLASGOW EXPOSITION.

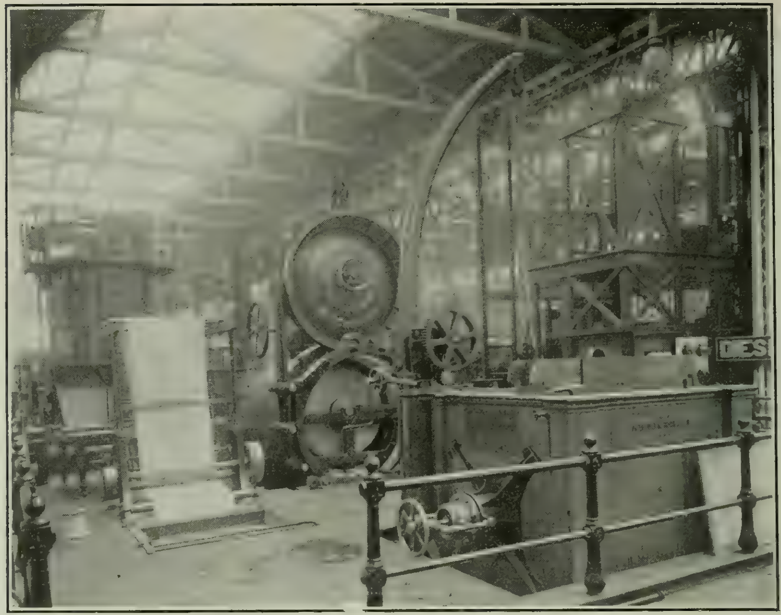
as well as at home. The portable electric drill has a motor of the enclosed type with cast-steel shell, and is mounted on wheels. In the coal-cutting machine the motor is arranged in the centre of the instrument. The cutting bar, which revolves at 400 revolutions per minute, has a series of cutting picks. In addition to the forward movement given by the haulage gear a reciprocating movement is provided for see-sawing the bar out and in, in the holings.

Another important electrically driven coal cutter is exhibited by Messrs. Clarke, Steavenson & Co. In this case the circular cutter works horizontally and the machine is so compact that the truck with its motor and gear may work its way through a face only 20 inches high and cut the seam level with the floor.

THE WESTINGHOUSE PAVILION AT GLASGOW.

It is not possible to overtake more than a few of the noteworthy applications of electricity to mechanism to be found in the Glasgow collection, and in referring to special cases I must not be considered as indifferent to such exhibits as those shewn by Messrs. Clarke Chapman & Co. of Gateshead-on-Tyne, the Sunderland Forge and Engineering Co., and other firms which have done distinguished service in this field.

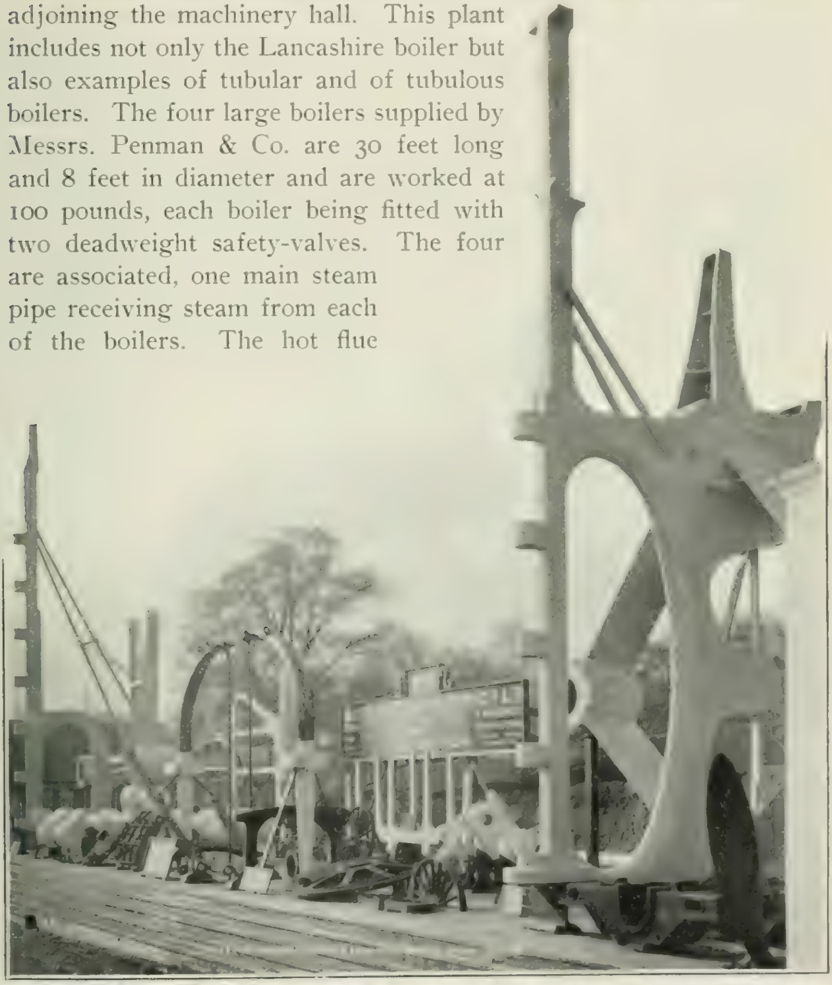
There is a special educative advantage in the many-sided exhibit of mechanical devices for the textile, manufacturing, printing and other industries, for it will be borne in on young West of Scotland engineers



MACHINERY FOR OPEN-BLEACHING SYSTEM.
By Mather & Platt, Salford, Manchester. Shewing a new departure in principle. The bleaching liquors are made to pass through the cloth in bulk, instead of the cloth passing through the liquors.

that there is an unlimited scope for their ability and ingenuity, and that there are many branches of engineering which promise quite as liberal rewards for successful efforts as electric and marine work. The machinery is shewn at work, and in this respect indeed the Glasgow Exhibition is certainly ahead of many of its predecessors. Accordingly we find an extensive and at the same time a typical display of prime movers. Here also, however, the Exhibition is virtually British, and there are few opportunities of comparing what is done by Britons in this department with that which is met with in America, in Switzerland, and in Germany. Yet it may be affirmed that the engine-builders and the constructors of electricity generators are more than holding their own in efficiency and originality of design and make. I would note in passing the extensive show of high-speed engines for electric generation on board ship. It is not to be wondered at, considering the place which the Clyde occupies amongst the great ship-building ports of the world, that there should be here such a full demonstration of the best modern practice in this branch of engineering. The engines referred to vary from comparatively small units up to engines of 150 horse power with generators giving an output of 200 kilowatts. There are two or three generators suitable for central stations for lighting and traction purposes, up to 1,200 kilowatts, driven by horizontal or by vertical engines, and also a machine of the marine type driving a large multipolar generator of 800 kilowatts. And so we have most systems illustrated. The voltage varies from 200 to 500. Several firms, however, and notably the British Shuckert, exhibit transformers dealing with currents of 10,000 volts, and in connection with these there are suitable switchboard mechanisms for such high potentials.

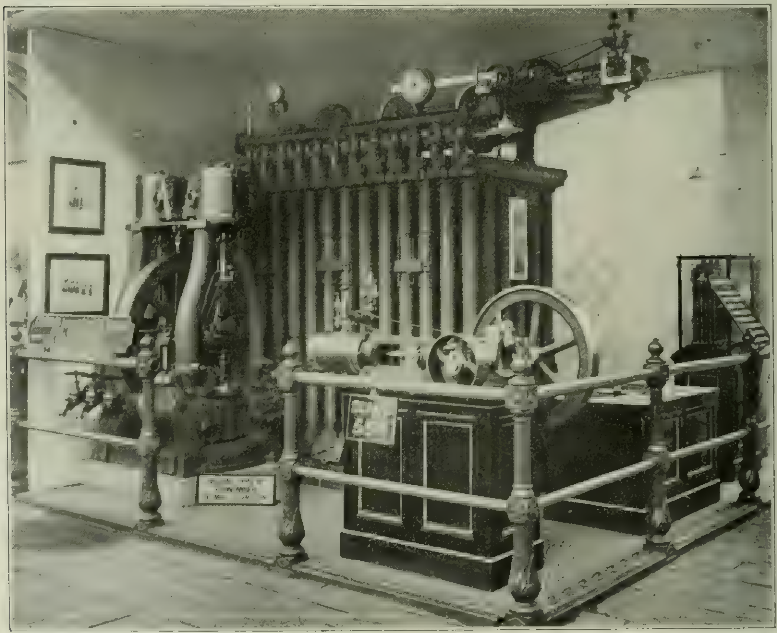
The steam-generating plant is accommodated in a special house adjoining the machinery hall. This plant includes not only the Lancashire boiler but also examples of tubular and of tubulous boilers. The four large boilers supplied by Messrs. Penman & Co. are 30 feet long and 8 feet in diameter and are worked at 100 pounds, each boiler being fitted with two deadweight safety-valves. The four are associated, one main steam pipe receiving steam from each of the boilers. The hot flue



OUTDOOR EXHIBIT OF THE DARLINGTON FORGE COMPANY. HEAVY FORGINGS FOR SHIPBUILDING AND STRUCTURAL WORK.

gases before reaching the chimney are utilised in a Green's economiser which delivers the feed at a high temperature. The steam-generating plant of Messrs. Davey, Paxman & Co. includes a tubular boiler, a superheater, and an economiser. The steam generated from this set is used at a temperature of 650° F. in the company's large horizontal engine driving a 500-kilowatt generator to which reference will be made later. Messrs. Babcock & Wilcox supply three water-tube boilers, two land and one marine.

As to the Stirling boiler, two examples of which are in action in the boiler house, one with a Vickar's stoker, the other using producer gas, the principal change made since it was introduced into Great Britain is in the adoption of two water cylinders instead of one. The Stirling boiler delivers dry steam. The Davey-Paxman superheater has been referred to; now to revert for a moment to the superheating arrangement which can be called into play in the Babcock & Wilcox boilers. Here U-shaped tubes, hanging below the drums in vertical planes with limbs horizontal, convey steam from the drums through the furnace gases and up to the steam-supply valve.

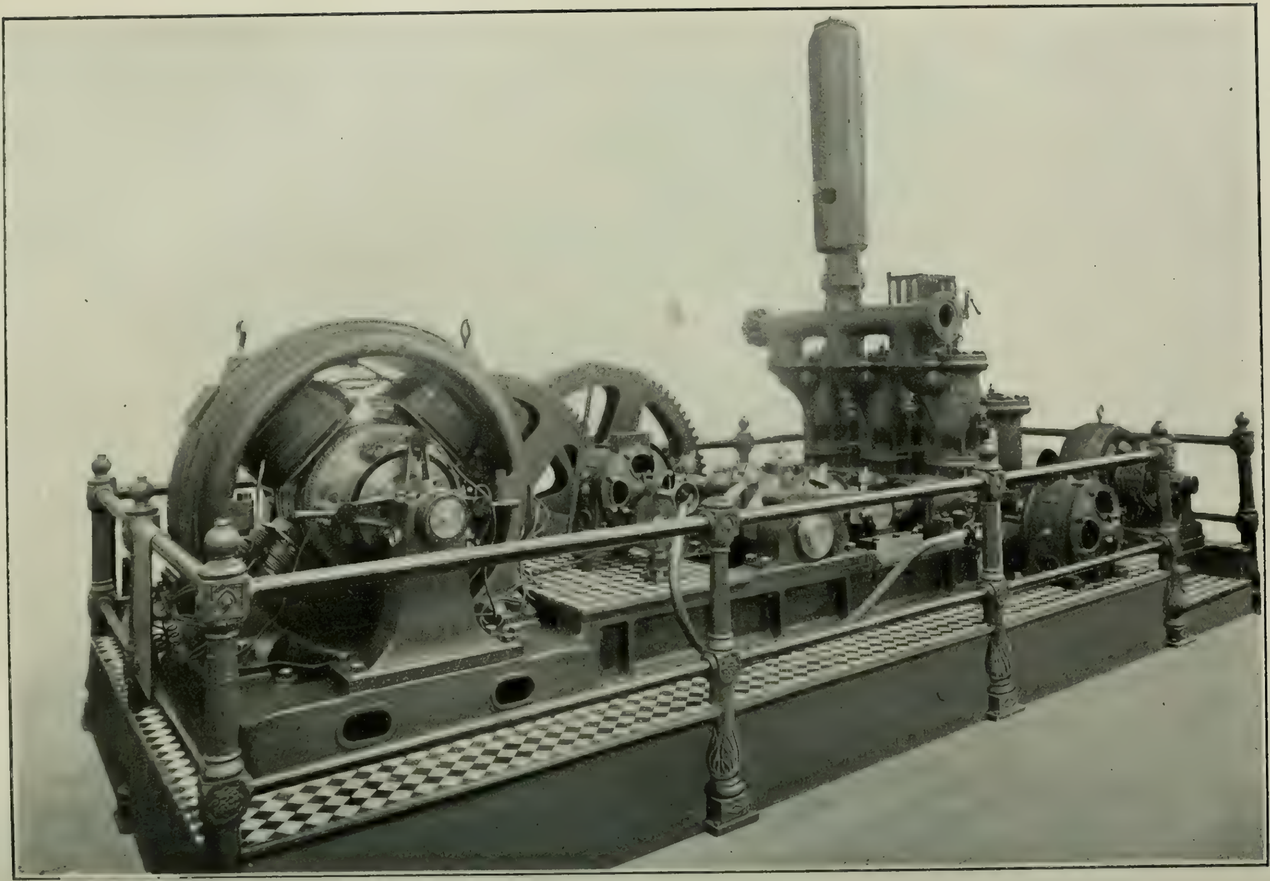


GLASGOW EXHIBIT OF GREEN'S FUEL ECONOMISER. SPECIAL TYPE FOR SMALL STEAM PLANT.

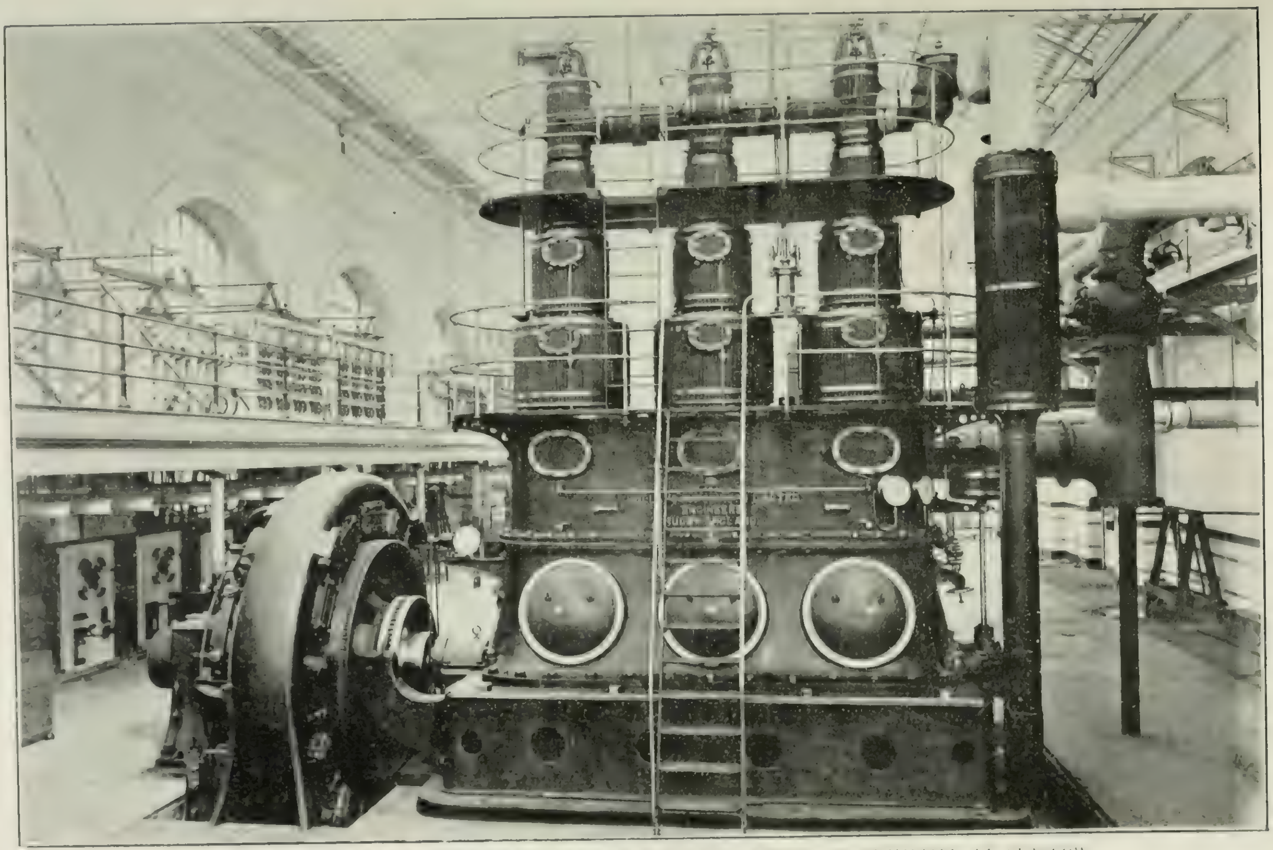
The question of superheating steam has from the first occupied the attention of engineers. With the rapidly growing demand for power plant to be used in electric lighting and for traction, there is increased desire to effect economy in steam consumption. The results of experiments carried out on a large scale point to gain in this direction from superheating. Excellent results have also been got in using superheated steam on board ship. The Central Engineering Works, Hartlepool, have introduced this system into three steamers. The working pressure in the boilers, as appears in a report which announced a coal consumption of 97 pounds per hour per indicated horse power, was 267 pounds and the temperature on leaving the superheater about 480° F.

WATERFALL SUPPLIED BY A WEIR PUMP, PUMPING OVER THE SAME WATER CONTINUOUSLY.
G. & J. Weir, Limited, Cathcart, Glasgow.

In connection with the boiler installation various systems of pumps are at work. There are two vertical pumps on Weir's well-known system with a capacity of 3,600 gallons per hour, two corresponding pumps on the Worthington system, and also two by Carruthers, of Glasgow, for dealing with 6,000 gallons per hour; but these respective systems are so well-known that there could be no justification for entering here into details. It may however be remarked that Weir's pumps are almost universally adopted in the British navy and that they work satisfactorily against a pressure of 600 pounds to the square inch. The steam piping is designed on the ring system, the maximum internal diameter being 12 inches. Separators and steam traps are provided to deal with condensation within the pipes, and the expansion joints are fitted with brass glands. Feed-water heaters are in use. Those supplied by Royle of Manchester are constructed on Row's principle, in which an ingeniously contorted surface separates the feed from the steam which supplies heat. The feed-heating system introduced many years ago by Weir has a special interest for two very important reasons. First of all there is beyond all question an increase in



ELECTRIC-DRIVEN PUMPING SET, EXHIBITED BY THE ELECTRIC CONSTRUCTION COMPANY, WOLVERHAMPTON.



THE CENTRAL VALVE ENGINE OF WILLANS & ROBINSON, RUGBY, AS EXHIBITED AT GLASGOW.

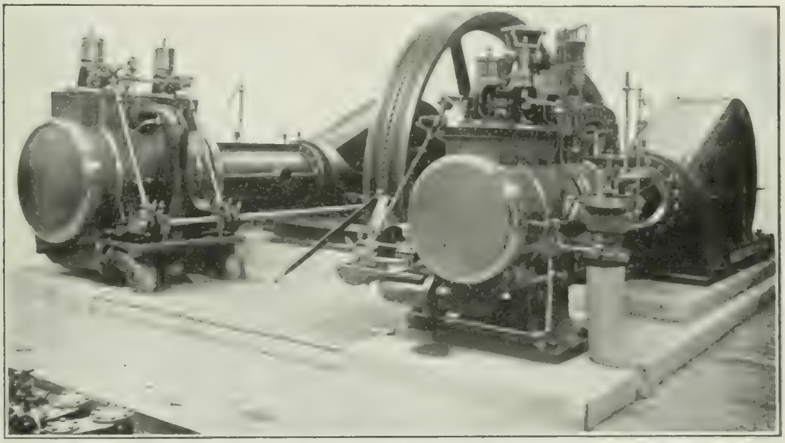
They have on display two engines, each of normal 1,200 h. p. with a maximum of 1,500 h. p. The engines are triple-expansion three-crank, with cylinders 9½, 13½, and 15 in. diameter and 17 in. stroke; 230 r. p. m.; steam at 180 lb. The cranks run in an oil bath in the bed-plate. At present they exhaust to the air, but they are intended to run with condensation. One drives a Crompton dynamo of normal 900 kw. at 250 volts, the other a Shuckert dynamo of equal output. Floor space 16 ft. by 8½ ft. Weight about 34 tons.

efficiency obtained by using in the feed-heater steam taken from the receiver of the low-pressure cylinder. This gain, which was outlined by the patentee in his original specification, has been got in practice and has also received an explanation at the hands of so eminent a physicist as Professor Cotterill. Secondly, there is a gain due to the influence which the method adopted for heating the feed-water has in eliminating corrosive gases.

Two noteworthy examples of engines are supplied by Messrs. Willans and Robinson, of Rugby. Their engines are 1,200 indicated horse power and of the central-valve type now largely adopted in central stations in Britain. Each engine has three cranks and each crank is worked with three cylinders on the superimposed system. The crank shaft is in one piece, with the eccentric forged solid on the crank pin. The uniform turning movement obtained by the multiple-cylinder system does away with the need for a large fly wheel and constancy of speed is further secured by the armature itself. To one of the engines a Crompton generator is coupled up, and to the other, one of the Schuckert multipolar generators shewn at Paris. Both these sets will have a permanent home in Glasgow, as they have been acquired for one of the electric-light stations of the Glasgow corporation.

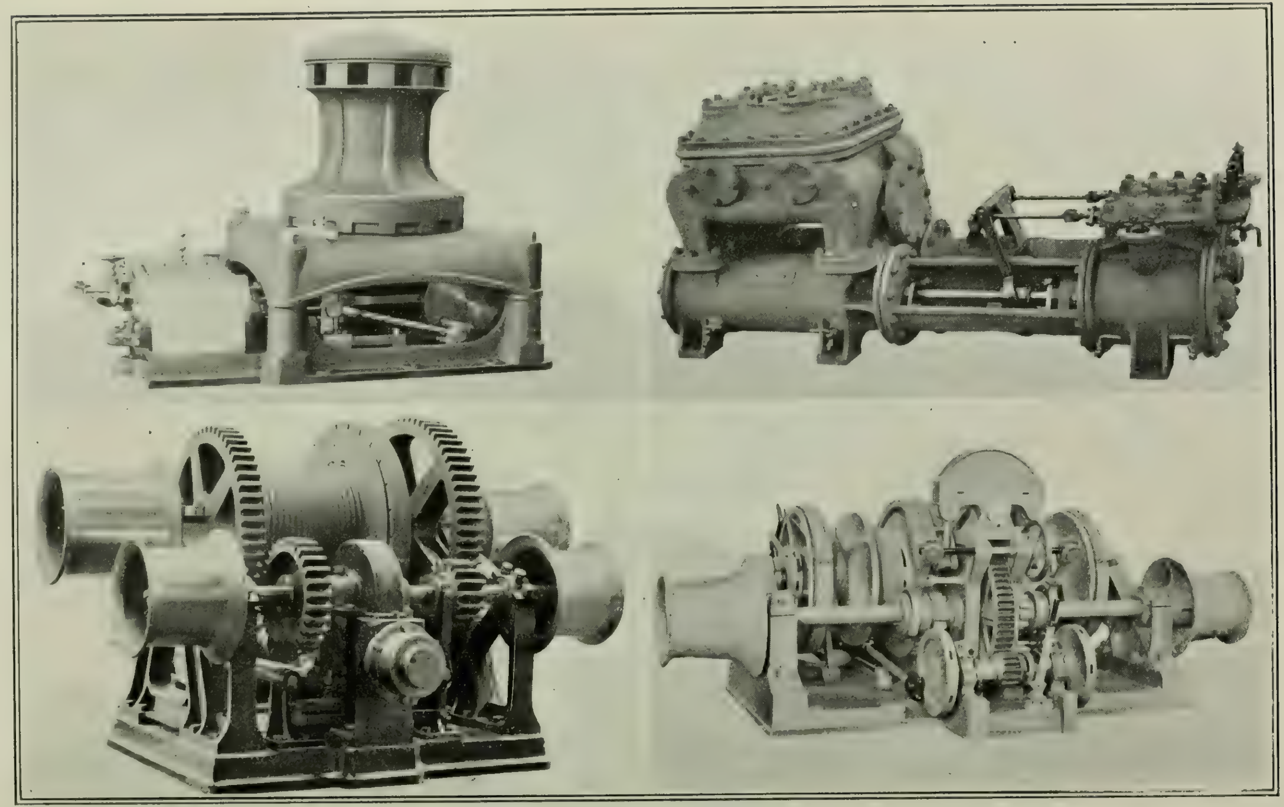
Alongside of these splendid vertical engines is a horizontal engine by Messrs. Davey, Paxman & Co.—a very powerful machine with two cylinders. The main bearings are 8 feet 6 inches apart, and between these is mounted a traction generator of 300 kilowatts by the Electric Construction Co. of Wolverhampton. The valve-driving gears are placed in front of each main crank, instead of being keyed on the crank shaft on the inner side of the main bearing. The makers have kept in view the advantage of shortening the main shaft on which the heavy flywheel and the armature of the generator are mounted. In order that rapid changes of load may not seriously affect the speed of the engine, Paxman's automatic expansion gear, operating the piston valves which admit steam into cored recesses round the main piston valves, is applied to the high and the low-pressure cylinders. The engine uses superheated steam. Between the cylinders is an inter-heater fed with boiler steam superheated and so raising the temperature of the high-pressure exhaust considerably above saturation temperature. The low-pressure exhaust heats the feed water.

Messrs. Richardson Westgarth & Co., Hartlepool, exhibit a marine engine coupled to a generator of 300 kilowatts by Messrs. Brown Boveri & Co. The engine, which is designed to work with steam at 160-pounds pressure and develop 600 horse power, gives an example of the firm's practice as regards marine work. The multipolar drum-wound generator gives a voltage of 230 when running 150 revolutions per minute. The 800-kilowatt generator, one of eight constructed for the Salford corporation tramways by Messrs. Mather & Platt of Manchester, is of the 10-pole compound-wound type. The armature is 8 feet 6 inches in diameter, while the commutator is about 7 feet and the shaft 15 inches. This large dynamo is driven by a Browett & Lindley 9-inch-stroke vertical engine at 100 revolutions per minute. Another engine worthy of note is that supplied by Robey & Co., Lincoln, and working one of Mavor & Coulson's 8-pole generators with an output of 350 kilowatts. This is the largest dynamo which has been constructed in Scotland. The engine driving it is of the cross-compound horizontal type with cylinders 20 inches and 35 inches diameter respectively and a stroke of 42 inches. At a standard speed of 90 revolutions per minute and a steam pressure of 150 pounds per square inch it gives an indicated horse power of 550. The frame is massive and the bearings large. Richardson's trip-gear admits steam in accordance with the load, and further control is secured by an electric regulator. Thus should it happen that short circuiting took place in the mains the engine would stop automatically.



COUPLED COMPOUND ENGINE BY ROBEY & CO., LIM., LINCOLN.

The marine section of the exhibition is most comprehensive in its display. A magnificent collection of models, in themselves works of art, is arranged in the Grand Avenue and the Machinery Hall contains a very large and instructive representation of all kinds of marine engineering. It was not to be expected that many examples of main engines for screw propulsion would be on show. Nor was that needed.



A GROUP OF STEAM AND ELECTRIC-DRIVEN MARINE AUXILIARIES, BY CLARKE, CHAPMAN & CO., LTD., GATESHEAD-ON-TYNE.

The capstan is worked in double or single purchase by a horizontal engine 7¾ by 12 inches, or can be operated by hand. The cargo or ballast pump, horizontal duplex low-service type, has steam and water cylinders each 9 in. diameter and 10 in. stroke, gun-metal cylinders, plungers, valve seats, and glands. The electric winch is operated by a continuous-current motor and can lift 3 tons at rate of about 60 ft. per minute on the barrel. The whipping drums, warp ends or barrel can be used together or separately. The windlass works by steam or by hand power and has direct drive between driving wheel and cable holder.

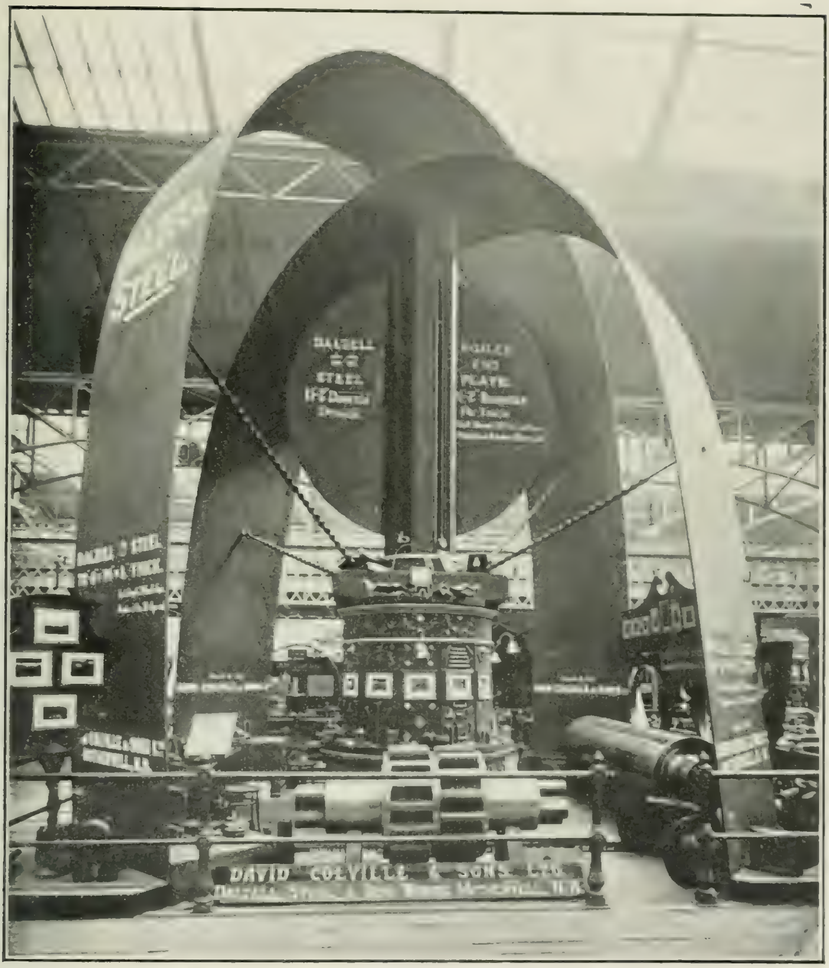


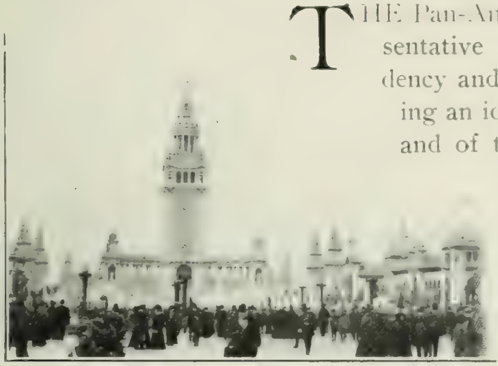
EXHIBIT OF IRON AND STEEL FORGINGS, CASTINGS, AND ROLLED SECTIONS.
David Colville & Sons, Ltd., Motherwell. The most striking exhibits are the steel plates, 72 ft. 6 in. by 74 in. by [illegible] in., and 65 ft. by 74 in. by [illegible] in.

for the design of such engines necessarily moves along well-defined lines, unless, indeed, one is looking to such complete departure from previous forms as is illustrated in Parson's Turbinia and King Edward VII. Interest gathers specially round auxiliary machinery. In boiler-feed pumps some firms already referred to have built up a reputation for the perfection and reliability of their appliances. There are many examples of deck machinery driven by steam or by electricity. The marine engineer of today deals with large magnitudes and the problem of strength is always present. Consider, for example, the anchor gear and brake arrangement needed to control the modern 20,000-ton ocean liner. Steel links of 3⅜ inches thickness now appear as the elements of great cables supplied to such vessels as the Oceanic and the Celtic. Within late years there has been a phenomenal development in size. But the other day the New York and Paris held a front place with a displacement of 10,000 tons. Now, at least fifty ships boast equal or greater tonnage. Twin-screw propulsion, as the models show, has become the rule and for the support of the propeller shafts the "spectacle" frame has been adopted. In addition to the increased facility with which the bearings can be examined, there is a further advantage from this arrangement, as tank experiments have indicated, in increased efficiency of the propeller. Brackets and other large forgings for Atlantic liners are exhibited by the Leeds Forge Co., Darlington Forge, Skoda, Beadmore, and others. The practice of scarfing the shell plating so as to reduce skin resistance has gradually extended and much larger plates are now being used than formerly. The Messrs. Colville of Motherwell shew a plate 72 feet long and 6 feet 1½ inch broad. One is tempted to enquire into the many changes which have been effected and to consider all the causes which have contributed to the reduction in coal consumption, for that of course is the vital question. Higher steam pressures, multiple expansion, higher piston speeds, heated draft, and superheating have all a share in the result, but perhaps instead of more pointed words it will be better merely to say that improvements in every direction have been and are being reached by naval architects and marine engineers and that this section, while possessed of great historical interest, must prove of special value on its purely scientific side.

MECHANICAL AND ELECTRICAL FEATURES OF THE PAN-AMERICAN EXPOSITION.

By Wm. S. Aldrich.

"To the great inventors and farseeing projectors, to the engineers, manufacturers, agriculturists, and merchants who have developed the resources of the New World, and multiplied the homes of Freemen."
Inscription, Panel I, Machinery and Transportation Building.



THE Pan-American Exposition is representative of the times—of the tendency and movement toward unfolding an ideal of international comity, and of the progress of civilization arising from the application of art and science to industry. It is a synonym for achievement. Passing through an age of discovery and a century of invention, the Western Continent is entering a period of development. The heritage of discovery left by Columbus was supplemented two hundred years later by Hennepin, the Humboldt of his day, accurately describing, illustrating, and naming Niagara. Scarce three-score and ten years have passed since Faraday discovered the principles of electro-magnetism that have made possible the utilization of this Niagara in an exposition which is the renaissance of the earliest Spanish influences to be seen in the art and architecture of the new world.

The grounds cover 350 acres, with 133 acres of improved park land. The court features cover 1,390,000 square feet, equal to the like areas of the Chicago and Paris Expositions combined. The architectural composition is true to new century ideals, the trend of the times in art and decoration, and the traditions and customs of the country. It is the product of American artists and architects, working out the problems of an exposition style with the old Spanish Mission as a starting point, into a complete and harmonious whole, unifying the composition in form, color, and sculptural decoration. By day it blends into a color scheme universally recognized at once as most appropriate and effective. By night it affords an opportunity for electric illumination of surpassing beauty.

It was originally planned to have two great buildings, Machinery and Transportation, Manufactures and Liberal Arts, one on each side of the grand court; but there have been added the Agricultural and the Electricity buildings, similarly situated. Demands continued to be made for space, especially for the railway exhibits so typical of American engineering development. To accommodate these the Railway Exhibit building was added beyond the propylæa bounding the northern end of the court. The floor space for exhibits is equal to three-fourths that of the Chicago fair—too small in which to gather exhibits representing all types of American industries.

The electrical development of Niagara Falls and the utilization of 5,000 horse-power of its energy for the exterior illumination has made it possible to carry out a scheme of unprecedented boldness and beauty in the decorative lighting of the grounds, buildings, and electric tower. The power is generated at the central plant of the Niagara

THE ELECTRICITY BUILDING, BUFFALO PAN-AMERICAN EXPOSITION.
Copyright, 1901, by C. D. Arnold.

Drawn by F. Hopkinson Smith. Carrere & Hastings, N. Y., Architects.

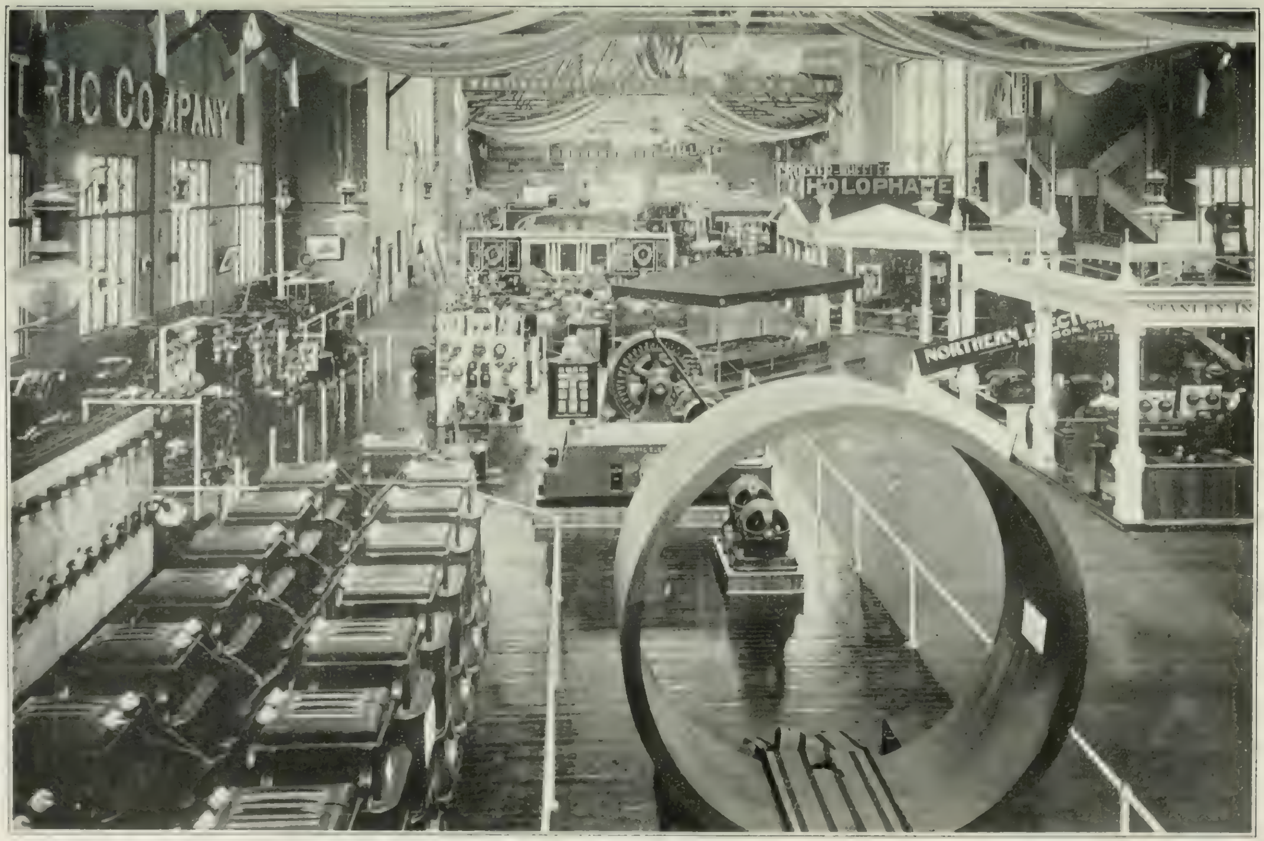
THE TRIUMPHAL CAUSEWAY, PAN-AMERICAN EXPOSITION.

Falls Power Company, as two-phase alternating current of 25 cycles at 2,200 volts. It is at once transformed to 22,000 volts, three-phase, and transmitted 20 miles over the copper and aluminum lines to the terminal station on Ontario Street, Buffalo, where the voltage is reduced to 11,000. The current is thence transmitted 13,000 feet by a double three-phase line, of six bare copper wires of No. 00 (B & S gauge) to the rheostat house, within the Exposition grounds, 650 feet north of the West Amherst Street gate.

The rheostat building is erected on posts, and houses the largest water rheostat ever built. It wholly controls the electrical supply for the exterior lighting. There are three water rheostats, one for each conductor of the polyphase current. Each rheostat consists of a tank, 3 feet wide, 3 feet deep, 7 feet long. Large blades, 6 feet long, are operated by a rope secured to a shaft driven through a worm gear by one-half horse-power direct-current electric motor. In this way all of the exterior incandescent lamps may be brought gradually up to full glow by lowering the blades into the water. The resistance diminishes till full metallic contact is made when the lamps are at full candle power. The water rheostat may be operated from the Electricity building and about 80 seconds usually elapse before the lamps are brought up to full incandescence.

From the rheostat house the Niagara power is transmitted through three lead-covered underground copper cables, of 300,000 circular mills each, laid in wood-box conduit, to the transforming sub-station in the northwest corner of the Electricity building. The lightning arresters, of the type made by the General Electric Company, are placed about ten feet from the underground cables. Entering the sub-station, the 11,000-volt current passes through an electrically-operated three-pole oil-break switch. This is of the type made by the General Electric Company, and adopted and first to be commercially used on a large scale in the power house and sub-stations of the Manhattan Elevated Railway, New York. It is operated by an electric motor, controlled either by hand from the main switchboard or by a magnetic overload circuit breaker, which closes the motor switch in case of a short circuit on the line.

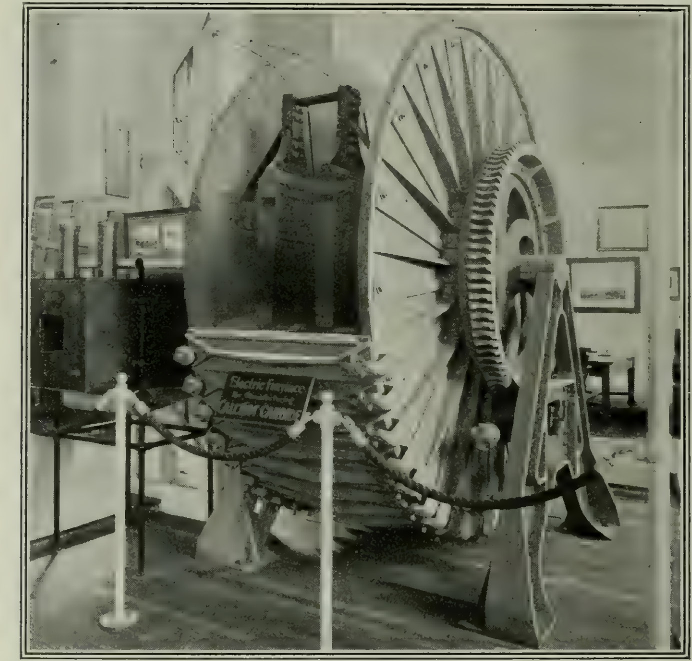
The transforming sub-station forms part of the exhibit of the General Electric Company, where eighteen 250-kilowatt air-blast transformers are installed, reducing the voltage of the Niagara current from 11,000 to 1,800. One extra transformer is held in reserve. This service is controlled through hand-operated oil-break switches and measured by an integrating wattmeter for each transformer. Adjacent to the transformers is the distributing switchboard, from which, through twelve three-phase feeder circuits, the current is supplied to the several transformer pits located throughout the grounds. There are about forty of these pits, containing various sizes of General Electric Co.'s oil-cooled transformers, reducing the voltage from 1,800 to 104, for the 8-candle-power incandescent lamps.



INTERIOR OF THE ELECTRICITY BUILDING, PAN-AMERICAN EXPOSITION.

In the left foreground is the transformer sub-station forming part of the General Electric Company's exhibit. The Westinghouse exhibit, shown on page 851, is at the extreme end of the hall.

Niagara power is not used throughout the Exposition elsewhere than for the exterior incandescent decorative lighting, and the alternating-current series arc lighting in the Electricity building. Its cost for this purpose is $30 per horse power, for the period of the Exposition, as measured at the Ontario Street terminal house.



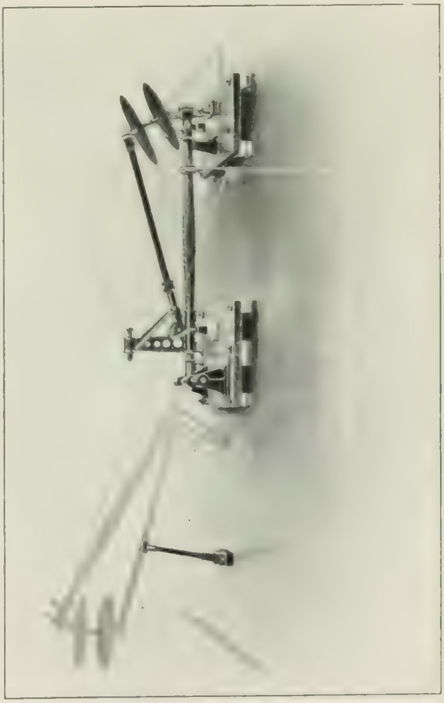
MODEL OF ELECTRIC FURNACE FOR MAKING CALCIUM CARBIDE, IN THE ACETYLENE BUILDING.

There is little to remind the visitor of the vast industries gathering about the Falls, except the model in the Acetylene building of the electric furnace for the manufacture of carbide of calcium. The Union Carbide Company, in its furnaces at the Falls, utilizes 20,000 horse-power of Niagara's electrical development, and the furnaces of other companies use 3,000 horse power for the manufacture of carborundum, 1,000 for graphite and 1,000 for emery products. The electro-chemical industries use 1,600 horse power for the manufacture of caustic soda and bleaching powder, 900 for sodium, 600 for phosphorus, and 500 for caustic potash and hydrochloric acid. The electro-metallurgical industries utilize 5,000 horse power for the reduction of aluminum, 600 for lead, and 100 for silver.

The use of models of great engineering developments for exhibition purposes is specially noted at the Pan-American. It becomes more and more necessary in consideration of the nature and size of units of modern engineering projects, and in an exposition like this representing widely-separated districts and industries. For instance, the electrical development of water power is illustrated by a model of the Niagara Falls power plant, shown in plan and partially operative sectional elevation; an electrical manufacturing establishment by the model, as exhibited at Paris, of the works of the General Electric Co., Schenectady, N. Y., illuminated to produce day and night effects; naval and marine engineering by models of battle-ships and other naval vessels and mail steamers in the service of the Government; military engineering by models of ordnance, fortifications, and coast defenses; high-potential long-distance electric transmission by the model of the Standard Electric Company's installation, California.

The latest phase in the development of California water powers is exhibited by this last model. It shows the tributary watershed, the storage and distributing reservoirs, as well as the contour of the country traversed by the line, all in relief. The lines are of aluminum and aggregate 217 miles, the longest single stretch being 145 miles.

The 60,000-volt combination switch and fuse for these most recent installations is exhibited by the Stanley Electric Manufacturing Co. Its operation depends upon drawing a metal fuse through a non-conducting powder enclosed in an insulated tube, the arc being ruptured as the fuse passes quickly through the powder. In its upright position the switch is closed. The fuse holder has large washers at each end and is held by the fuse which passes through it, between the vertical (main) arm and an auxiliary arm. The fuse carries the main circuit. An interlocking


60,000 VOLT COMBINATION SWITCH AND FUSE.
STANLEY ELECTRIC MANUFACTURING CO.
The third position is shown in skeleton.

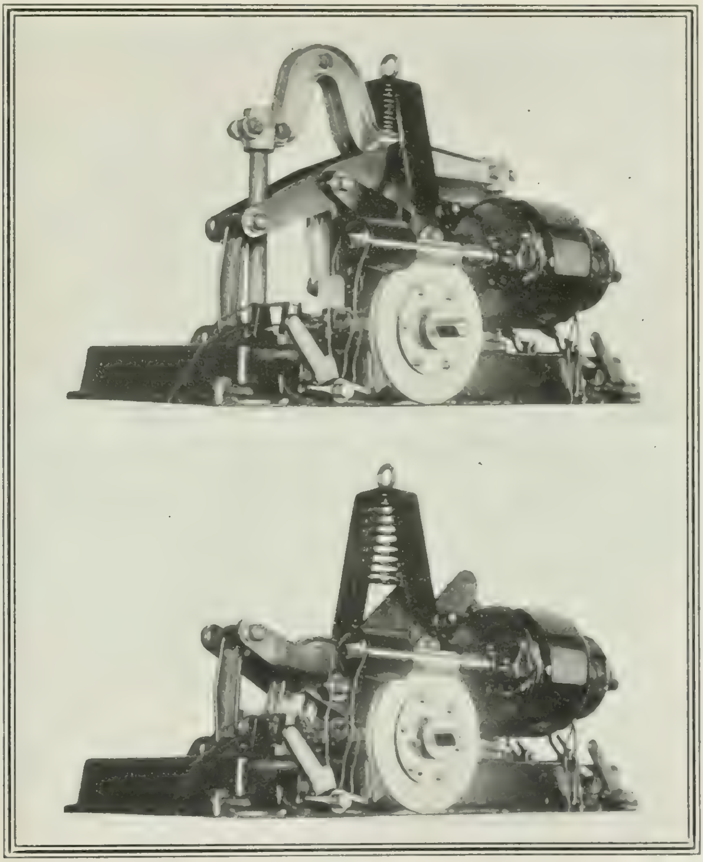
device prevents the circuit being broken at the terminal jaws till the auxiliary arm has dropped into a horizontal position, assuring the circuit being open at the fuse. To open the switch by hand the upper end of the fuse is released by an unlatching arrangement provided for the purpose. The auxiliary arm is normally under the tension of a spring, assisting its pulling the fuse quickly through the powder. The automatic operation of the combination, from a short-circuit or other overload, is precisely similar, except that the fuse is fused and parted within the tube, instead of the upper end being released.

The question of fuse protection of high-potential circuits has also been satisfactorily solved by the same company, in their exhibit of 30,000-volt "ball" fuses. They are so constructed that when the fuse proper blows, carbon balls are driven into the air chambers arranged as receptacles and the arc is effectually ruptured.

In another new type of high-tension circuit breaker, exhibited by the General Electric Co., the break is made inside a long tube. The heated gases incident to the break throw out the piston which makes the contact, so breaking the arc, with a downward motion of the pistons, forming a double break on each phase.

The latest machine of the new type of compensated revolving-field alternator is exhibited by this company in a 200-kilowatt unit for direct connection to prime mover, to generate three-phase current at 2,300 volts, 60 cycles. It is specially designed to overcome the greatest difficulty in alternating-current supply, that of proper regulation of the voltage. The exciter is mounted on the machine and driven by enclosed gearing, to maintain it at a definite phase relation with the armature. Three collecting rings on the exciter armature are connected to the secondary of a transformer in series with the main circuit, increasing the voltage of the exciter with the load without any rectifying devices. This ensures better compensation for drop in voltage than is obtained by the usual earlier automatic methods, and maintains accurate voltage regulation under all varying external conditions of the load, for arc or incandescent-lighting or power service.

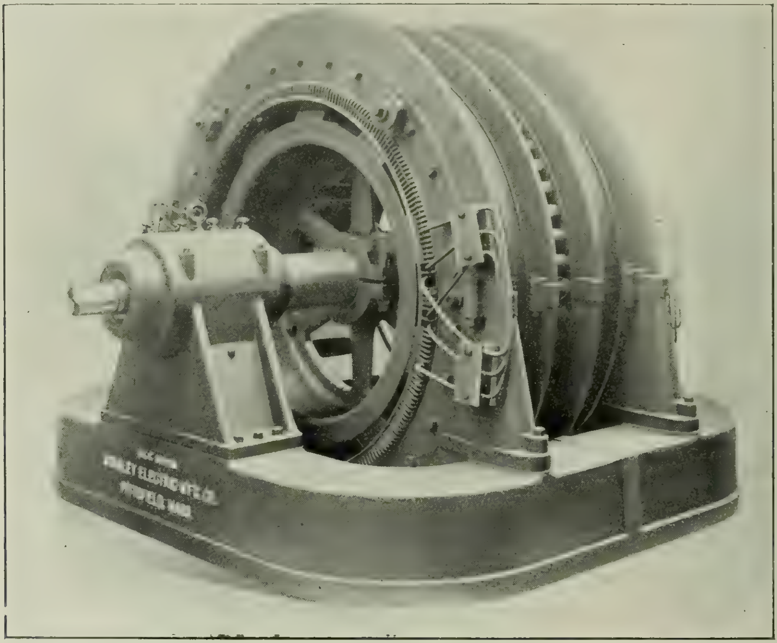
Alternating-current series enclosed-arc lighting, now coming into extensive use, is shown as a complete installation by the same company for lighting the interior of the Electricity building by this system. Niagara power is taken from the main transforming switchboard and reduced through three 50-kilowatt oil-cooled transformers, from 1,800 to 360 volts, for operating a 200-horse-power synchronous motor at 25 cycles. This machine is belted to a 100-kilowatt compensated revolving-field constant-potential alternator, generating current at 2,300 volts and 60 cycles, as required by the arc-lighting service, supplied through the 75-light constant-current series transformer. This double transformation of electric energy, in voltage and frequency, by static transformers and motor-driven generators, as in the case of Niagara power above noted, is accomplished in one machine



ELECTRICALLY OPERATED OIL SWITCH, 300 AMPERES, 10,000 VOLTS. SHOWING TWO POSITIONS.

General Electric Company's Exhibit.

by the "S. K. C. frequency changer" exhibited by the Stanley Manufacturing Co. It is of 80-kilowatt capacity, operating on three-phase current of 1,800 volts at 25 cycles, transforming it to two-phase, 2,250 volts, 60 cycles. An inductor alternator with a separate phase regulation by the same company, in the service power house of the Exposition, is of 300-kilowatt capacity, driven at 300 revolutions per minute by belt from a Phoenix Iron Works engine, generating two-phase current at 60 cycles, of 2,400 (maximum) volts, operated at 2,200 volts, having a regulation of 20 per cent. The method of regulating the pressure in the individual phases is not shown in any other type of generator exhibited. It is accomplished by changing the effective turns on the armature by hand controller, cutting in or out the regulation coils and so raising or lowering the electromotive force of each phase independently.



THE STANLEY ELECTRIC MANUFACTURING COMPANY'S FREQUENCY CHANGER.
For changing current of low frequency to any required higher frequency and phase relation, especially in connection with lighting service.

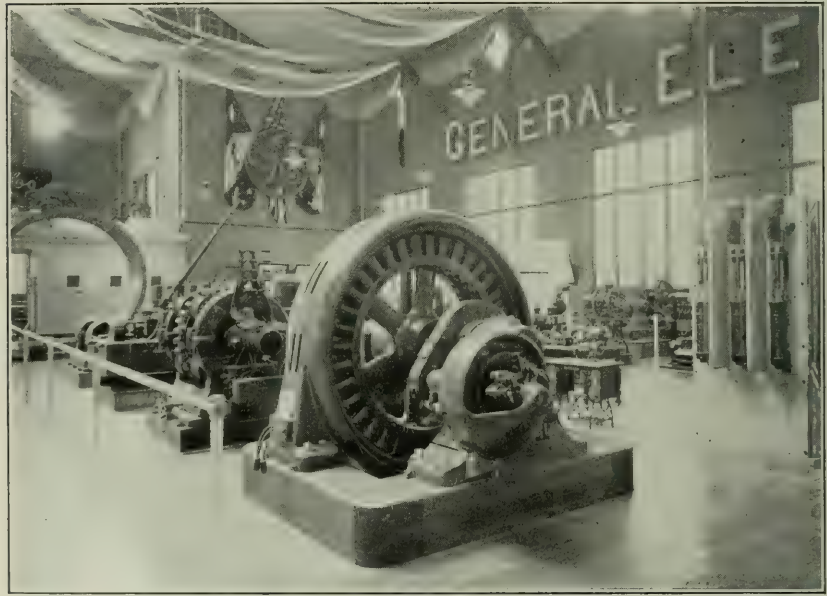
The Nernst lamps in the grand dome of the Electricity building and below, around the Westinghouse exhibit, produce most beautiful lighting effects. This is specially noted in the early evening, upon comparing the illumination by arc and incandescent lamps with and without the Nernst lamps. When the current is turned on there is noticeable the characteristic way in which the Nernst lamps come to a full glow, with an agreeable acceleration of the glowing effect entirely lacking in the incandescent lamp. The 50-candle-power lamps reach full glow in from 15 to 20 seconds, the 175-candle-power in 25 to 30 seconds, the 400-candle-power in 30 to 45 seconds. They are all operated on the alternating-current circuit of the Westinghouse exhibit, at 60 cycles and 220 volts.

The color value of the Nernst lamp is unapproached by any other electric light. It is practically equal to sunlight in enabling one to match or detect delicate shades or tints in all classes of fabric or other material. Measurement of the comparative energy, in watts, required by a Nernst and an incandescent lamp of the same candle power constitutes another feature of this exhibit. The lamps and wattmeters are placed side by side. Numerous experiments have shown that the efficiency of the Nernst lamp is 1½ watts per mean spherical candle power against the usual 3½ watts for the same candle-power unit of the incandescent lamp.

The possible combinations of the Nernst unit adapt it for making lamps of various candle powers as required. The unit for all lamps is the 50-candle-power glower. For instance, three glowers are arranged, in multiple, to produce 175-candle-power Nernst lamp, six glowers for the 400-candle-power lamp, etc. It is therefore possible to supply an electric lamp of any candle power desired, between the ordinary 16-candle-power incandescent and the 450-candle-power arc lamp, as shown by the 175-candle-power Nernst lamp in use in the exhibit. The life of the Nernst lamp is double that of an incandescent lamp of the lowest watt consumption for the equivalent candle power. While the incandescent lamp rapidly falls off in candle power after the first few hundred hours of use, the Nernst lamp holds up to full candle power for practically its whole life. It only shows an appreciable falling off for the last 100 hours, and then the depreciation amounts to about 2 per cent. of its candle power.

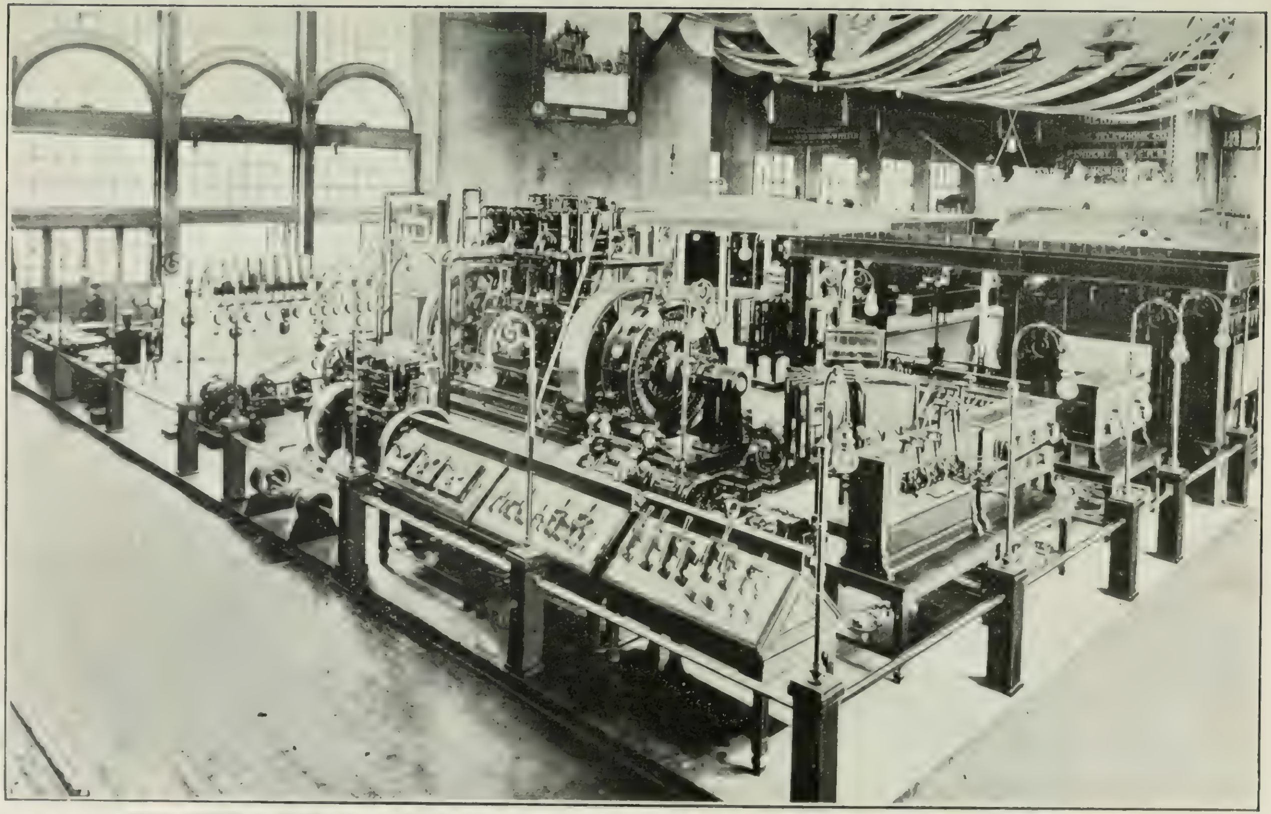
Each glower in any of the combinations required for the various candle-power lamps is supplied with its own automatic heating and regulating device. The glower itself is composed of rare earths in the form of a rod of enamel joined at the ends to a platinum wire, making a rod about 1½ inches long and $^{1}/_{32}$ inch in diameter. Back of the glower is the heater, made of a platinum-wire-wound porcelain tube making a cylinder about ⅛ inch in diameter. Practically no current flows through the glower at first, owing to its being a non-conductor when cold. It is rapidly heated, however, by the rush of current through the heater coil, and reaching a high temperature becomes an excellent conductor. The glower receives its current through a small regulator made of iron wire enclosed in a glass tube. In series with the regulator and glower is the control magnet of the heater coil. When the current flows through the glower and regulator it passes next through the control magnet, energizing it and cutting out the heater coil, of no further use when the lamp has been brought into service.

Exhibited at the Paris Exposition, in experimental form, the Nernst lamp has been so far perfected and developed by Mr. George Westinghouse, holding the rights for the United States, that the exhibit at the Pan-American may be considered epochal. This is the first public exhibition of Nernst lighting in America. Lamps are here shown in daily use, varying in siezs from 50 to 2,000 candle power, the total exhibit being equal to 50,700 candle power.



PART OF THE GENERAL ELECTRIC COMPANY'S BUFFALO EXHIBIT.

The transmission of power by gas and its direct utilization in distant gas-engines for the generation of electricity, when and where required, is in marked contrast to the local electrical development of water powers and the transmission thence to the required spot. This Buffalo Exposition affords most interesting examples of each of these rival systems. Under the same roof of the Electricity building may be seen the models of the near-by electrical development of Niagara, with its 22,000-volt transmission; the distant development of California water powers with 60,000-volt transmission; and the local generation of electric power in the 300-horse-power direct-connected Westinghouse gas engine, supplied by natural gas from the Bradford fields, Kane county, Pennsylvania, 100 miles distant. The 2,200-volt

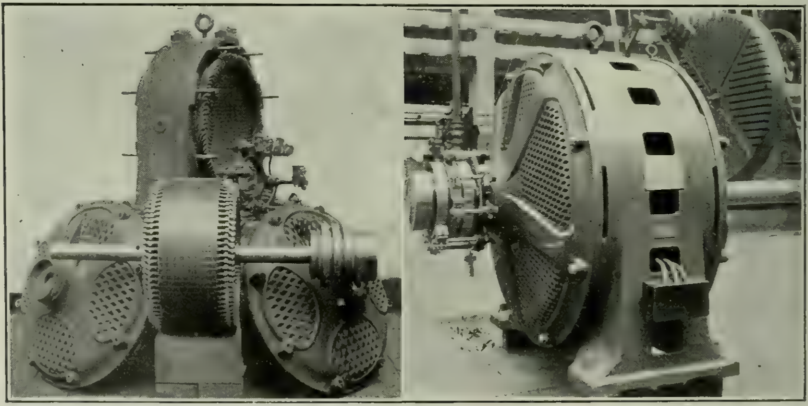


THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY'S EXHIBIT IN THE ELECTRICITY BUILDING, PAN-AMERICAN EXPOSITION.

60-cycle two-phase current here generated by a revolving-field alternator is used exclusively throughout the Westinghouse exhibit, principally supplying the Nernst lamps. A smaller 35-horse-power gas engine of the same type—that of the three-cylinder four-cycle—is direct-connected to the 25-kilowatt 125-volt direct-current generator, in the same exhibit.

Stationary gas-engines are exhibited of a dozen different forms, direct-connected or belted to dynamos, or belted to rotary pumps. Single-cylinder and two-cylinder (tandem) to three-cylinder vertical types are shown, the latter apparently having the preference.

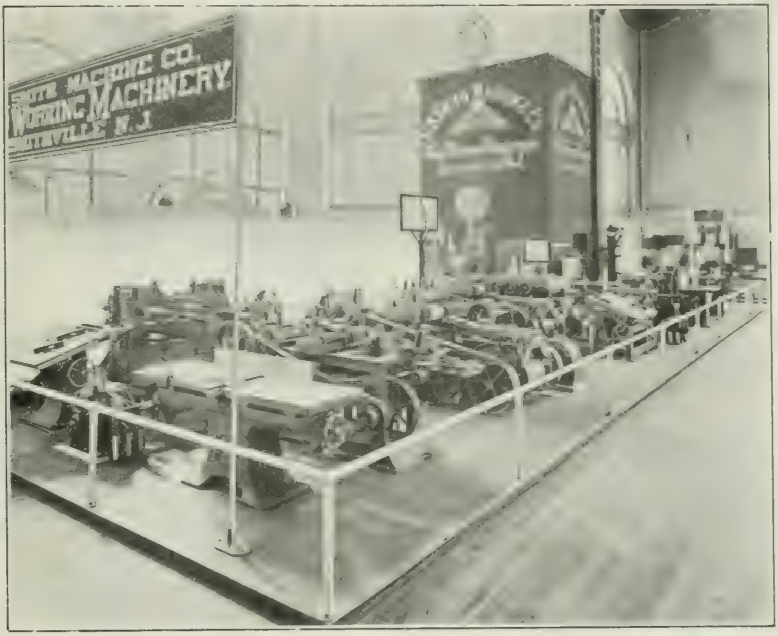
The applications of electricity at the Exposition to power service are necessarily more varied than the lighting. They represent radical and successful departures, especially in the line of polyphase working, for which service induction motors are now made for both constant and variable speed. Two-phase variable-speed induction motors are exhibited by the Westinghouse Company. They have a regular armature winding for the rotor or secondary, connected up for three-phase star grouping, with terminals brought out to three collecting rings. Wires are run from these rings to a controller with non-inductive resistances, by varying the amount of which, in the secondary circuit, the speed may be varied at will. The speed is lowered below the normal by cutting in these resistances as part of the secondary circuit, which is thus always closed on itself through such variable external resistance.



WESTINGHOUSE VARIABLE SPEED TWO-PHASE INDUCTION MOTOR, 200 HORSE POWER.
On the left the parts are shown grouped; on the right is the completed motor.

Individual induction motors operate each machine of the complete wood-working establishment, exhibited by the Smith Machine

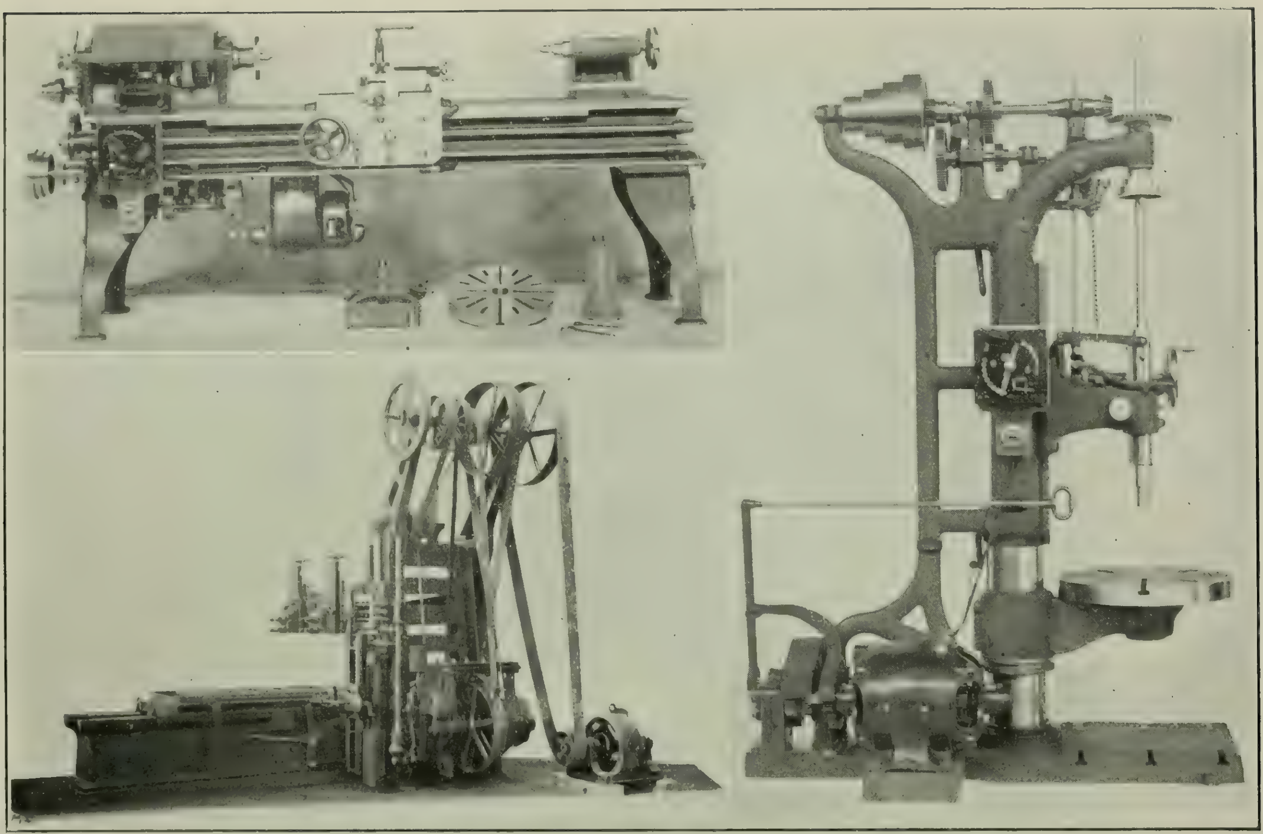
Co. in the Machinery building. These motors are of the Westinghouse two-phase constant-speed type, belted to the usual counter-shaft installed with each machine, and are made with the secondary or rotor of the ordinary short-circuited "squirrel-cage" construction. The only single-phase induction motors exhibited are those by the Wagner



WOOD-WORKING ESTABLISHMENT OPERATED ENTIRELY BY INDUCTION MOTORS.

Electric Manufacturing Co., in sizes from 2 to 30 horse power. This type of motor has but a single field winding, which through the connections provided in the simple self-starting arrangements makes it possible to start under full or over-load, as desired. A portion only of the armature is initially connected in series. A governor within the armature, on its attaining full speed, throws out this connection, and the armature is thence short-circuited on itself, the machine operating as a single-phase induction motor. A Wagner 5-horse-power 104-volt single-phase induction motor is direct-connected to a 25-volt direct-current generator for storage-battery charging in the Bell Telephone exhibit.

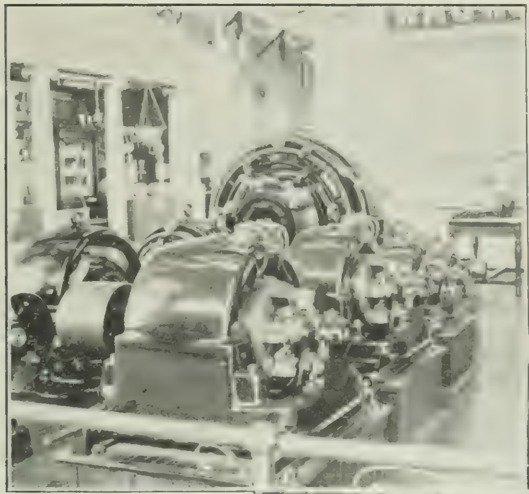
The Bullock system of power distribution, sometimes known as the "teaser" or multi-voltage system, for direct-current service is exhibited by the Bullock Electric Mfg. Co. The distribution is by multi-circuit wiring from the generator, supplying two or more



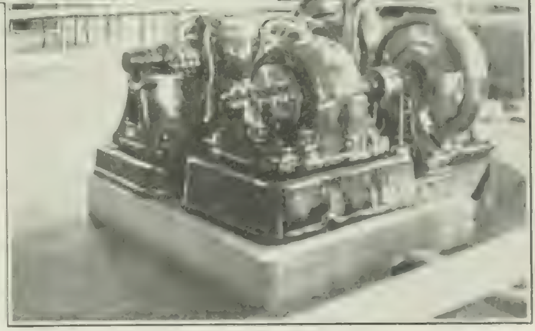
A GROUP OF ELECTRICALLY DRIVEN MACHINE TOOLS.

On the right is a 28-inch swing drilling machine operated by 2-horse-power electric motor; above on the left is a 16-inch swing engine lathe driven by 1-horse-power constant-speed motor. These are both exhibited by Prentice Bros. Co., of Worcester, Mass. Below on the left is a large tool driven by belted motor—a 42-inch open-side iron planer made and shown by the Detrick & Harvey Machine Co., of Baltimore. This machine is also built self-contained, with the motor carried on a bracket.

voltages as may be required to give the desired number of speed changes in the motors. These are therefore direct-connected or mounted on the machines to be driven and are operated through special controllers. Hence no wasteful resistances are employed as in the ordinary speed control of direct-current motors by variable rheostats or resistances. A Bullock motor of 6-horse-power, 220-volts, 350 revolutions per minute, drives a planer of the American Tool Works Co. in the Machinery building. Electric power distribution is seen in the driving of machines and tools. It has passed the experimental stage. In the Exposition are to be noted two modifications of the much-sought direct method of driving. First, the use of a constant-speed motor, with the usual mechanical arrangements of speed cones and change gears to obtain speed variations, making unnecessary any structural changes in the design of the machine. Second, the use of a variable-speed motor, with most direct connection possible to the spindle of the machine. There is a marked tendency to adopt the former method, not from any reluctance of manufacturers to change designs to adopt electric driving, but as the result of experience with variable-speed motor service. On a 16-inch lathe of one of the types exhibited



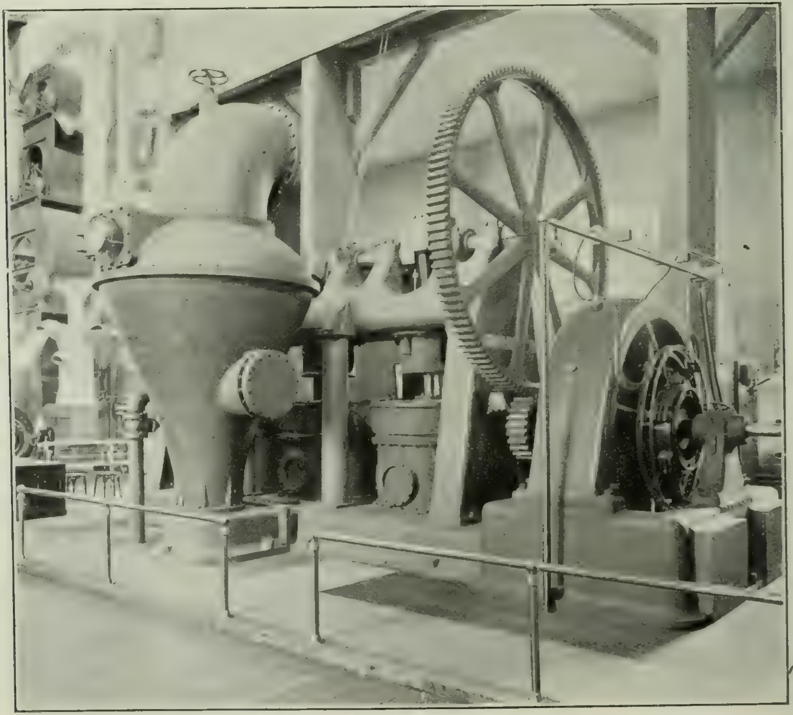
WAGNER SINGLE-PHASE INDUCTION MOTORS.



APPLICATION OF WAGNER INDUCTION MOTORS TO STORAGE-BATTERY CHARGING, BELL TELEPHONE EXHIBIT.

and driven by the former method, a ¾-horse-power 230-volt motor has been found more than ample, the lathe when so driven being capable of doing more work than by a belt drive, and all that the cutting tools will stand. Heavy torque crane motors and motors fitted with magnetic solenoidal brakes, not elsewhere shown, are exhibited by the Crocker-Wheeler Co., who show also a direct-current motor operating the hydraulic mechanism of a Gruson turret. The application of electric motors to heavy ordnance is shown also by the General Electric Co., for operating the disappearing carriage of a large coast-defense gun in the Government ordnance group.

Electric pumping is in evidence on every hand, both by alternating and by direct-current motors. Unprecedented application has been made in the exhibit of the Worthington 10,000-horse-power triplex electrically-operated air pump. It is driven by a single-reduction 150-horse-power 500-volt direct-current six-pole motor of the General Electric Co. Westinghouse direct-current 500-volt motors are in



ELECTRIC-DRIVEN AIR PUMP AND CONDENSER, 10,000 HORSE-POWER.

Exhibited by Henry R. Worthington. One of eight designed for the Manhattan Elevated Railway Power House, N. Y.

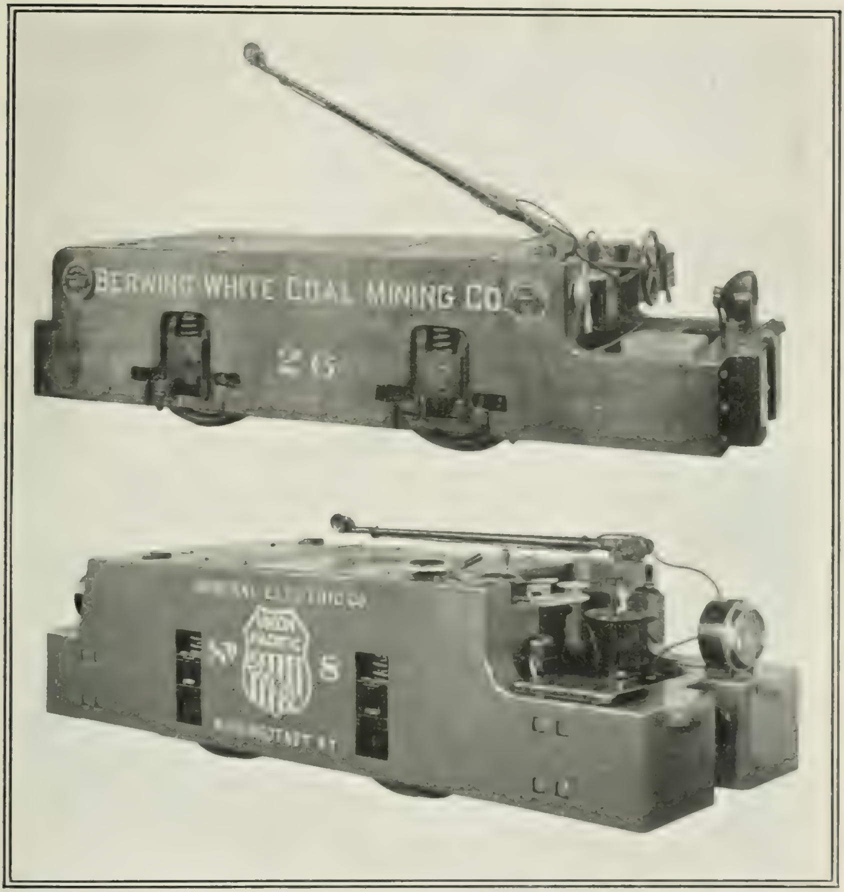


EXHIBIT OF ELECTRIC MINING LOCOMOTIVES—THE UPPER BALDWIN, THE LOWER GENERAL ELECTRIC.

The General Electric locomotive weighs 10 tons, has two 30-horse-power motors for 500-volt line current, exerts a draw-bar pull of 4,000 lbs. on level, or of 5,000 lbs. at starting, and attains a speed of 8 miles per hour with full load.

use for driving Roots' rotary pressure pumps; and in a mining exhibit a 50-horse-power General Electric three phase induction motor is geared by single-reduction to a triplex or three-cylinder pump, running at 120 revolutions per minute.

Electric elevators and hoists are exhibited, from mine hoists operated by 500-volt direct-current geared motors, of the street car type, to the superb exhibit of the Otis elevator in the Electric Tower. The automatic electromagnetic control for the Otis system constitutes an object lesson in itself, open for inspection on the ground floor of the tower. Electric traction, for flanged equipments, is represented by mining locomotives exhibited by the Baldwin-Westinghouse and the General Electric Companies. The ordinary requirements for such service are met by two 500-volt single-reduction motors, to develop 50 horse power on normal railway rating, at speed of six miles per hour, and with a capacity of 100 horse power at speed of eight miles per hour, on level. The full-load draw-bar pull, on level, is about 4,300 pounds; the starting draw-bar pull, on level, 6,000 pounds. Rheostatic control is chiefly used, and the total weight of locomotive is about 26,000 pounds. The new multiple-unit system as it is to be applied on the Manhattan Elevated Railway is publicly exhibited for the first time by the General Electric Co.; 125-horse-power motors are shown with the auxiliary parts of the equipment for one car.

A new electromagnetic brake and car-heating apparatus is shown by the Westinghouse Co. in two exhibits: first, a maximum traction double-truck equipment, with two 40-horse-power motors and brake, operated on a short section of track, from stationary controller, to show the great braking power of the system and the freedom of the wheels from skidding; second, a standard single-truck electric car similarly equipped and in operation. A simple additional mechanism to an ordinary street-car controller makes it possible to operate the motors as generators, when the car is in motion and disconnected from the line supply. Current is now supplied by the motors as generators, for exciting the brake magnets, through the friction shoes of which a strong magnetic attraction is set up with the rails, the drag of which operating through suitable levers applies the regular brake shoes to the wheels.

The self-propelled vehicles and launches constitute an exhibit of never-ending interest, from the many attempts to solve the problem by electricity, by steam, and by internal-combustion engines. About one-half of the automobile exhibit shows steam-driven vehicles, the other half dividing the honors equally between electric motors, operated by storage batteries, and some form of gasoline motor. One is specially impressed by the refinement in design and workshop production, evident in these attempts to obtain necessary power at high and variable speeds with minimum weight and size of equipment.

An application of electrically-operated control for steam-engines is shown in the Monarch engine-stop system, applied to the Fitchburg engine in the pumping plant. This engine is 18 by 42 inches, developing 250 horse power at 86 revolutions per minute, and operates one of the Roots' rotary pumps. The Monarch safety system is operated by electricity and gravity combined. The electric parts of the device serve to connect different parts of the plant, as may be desired, near or remote, with the throttle-valve, by means of push buttons, and also directly with the shaft to stop the engine in case of racing or over-speed. Pressing the button at any point, in case of accident, will unlock the system, closing the throttle-valve by gravity.

Telegraphy and telephony are well represented by some of the latest types of conventional equipment showing a high state of the art. The telautograph and electrograph are also exhibited, the former for reproducing handwriting and the latter for reproducing pictures at a distance. Interest in wireless telegraphy for the time overshadows that earlier shown in X-ray developments. The former is illustrated by an exhibit in the Government building, the latter by apparatus in the Electricity building, by means of which most remarkable and exact determinations are shown to have been made of the location of metallic bodies in the human system.

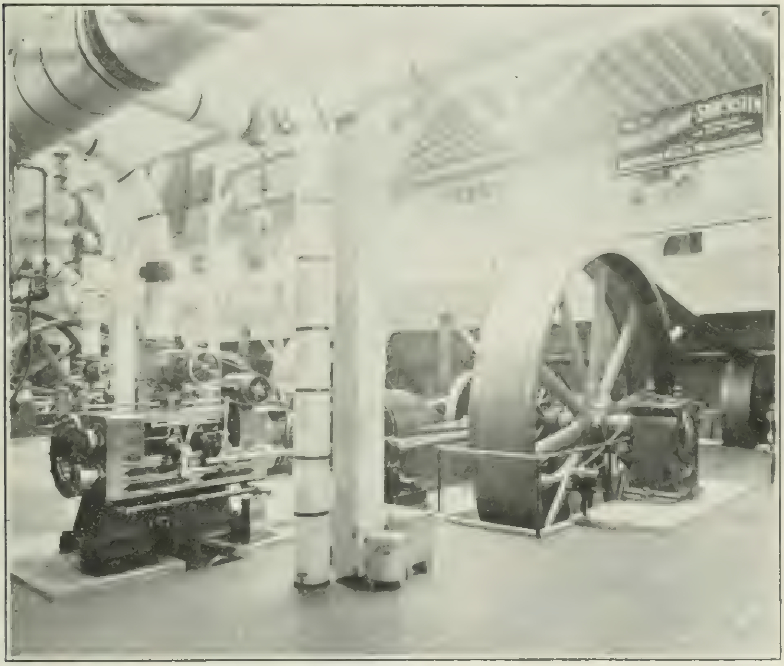
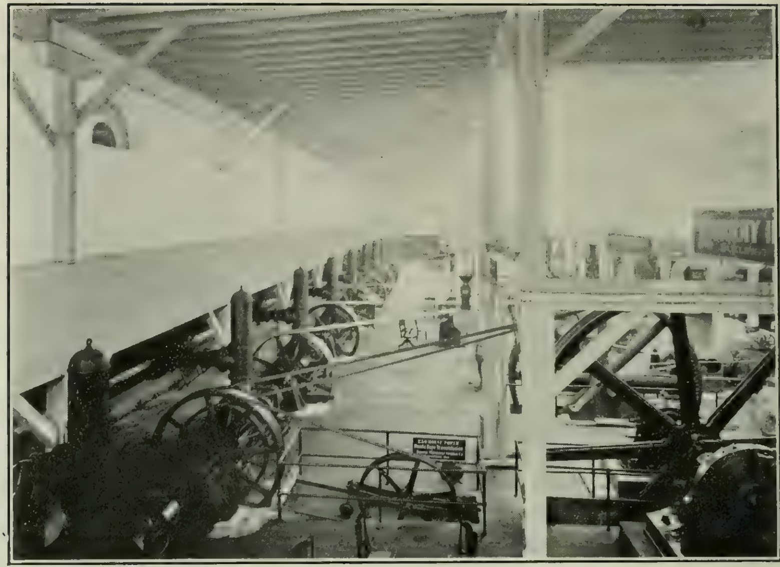


EXHIBIT OF THE MONARCH ENGINE STOP SYSTEM

The pumping plant in the court of the Machinery building contains a most interesting collection of steam and gas engines, of various makes, belted respectively to twelve Roots' rotary pumps.



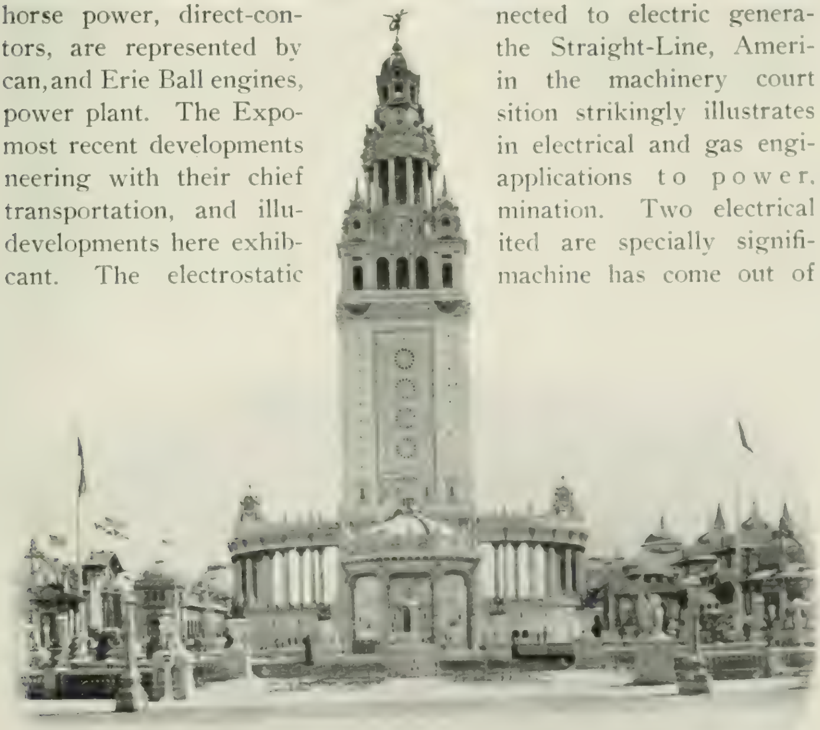
STEAM PUMPING PLANT, COURT OF MACHINERY BUILDING.
Showing exhibit of fountain pumps, P. H. & F. M. Roots Co., Connersville, Ind.

There are five other pumps of this type on the grounds, handling the water in connection with the fountains, cascades, etc., of a combined capacity of 35,000 gallons per minute and absorbing about 2,500 horse-power. Water is supplied through a 48-inch suction pipe intake and delivered through 16-inch and 20-inch pipes, at 110-pounds pressure, to the fountain orifices.

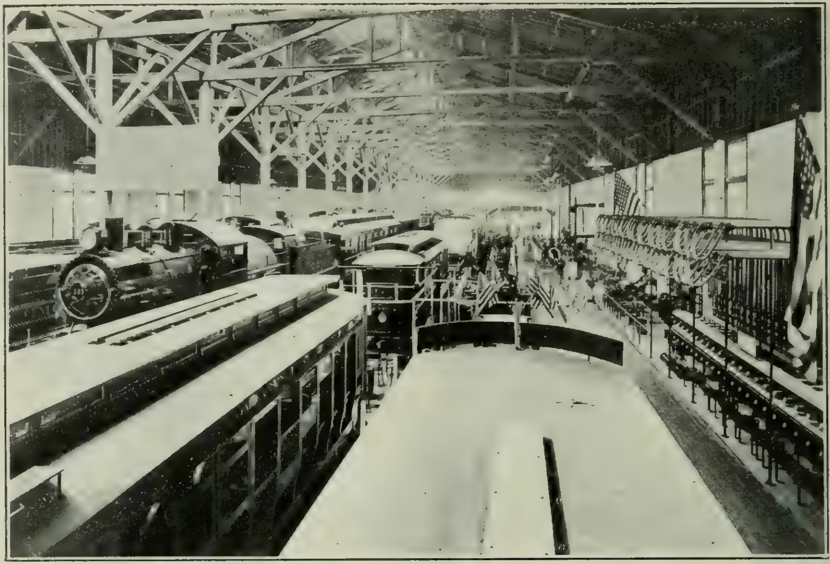
The American Ball compound engine in this power plant represents a radical departure in high-speed-engine design. The two cylinders are placed side-by-side, operated by a single valve, with their piston rods connected to the same cross-head. The principle employed is similar to that shown in the Vauclain type of compound locomotive for the Lehigh Valley R. R., No. 1211, exhibited by the Baldwin Locomotive Works, in the Railway Exhibit building. A saving of 25 per cent. in fuel over the simple engine is claimed for this system of high-pressure compounding.

The railway exhibits, in the small building set apart for them, are as thoroughly representative as possible of the peculiarly American transportation systems and safety appliances. Even to the layman it will be evident that every precaution is taken for his safety in travel, from the exhibits and operating models of installations of the Westinghouse and New York Air Brake systems, the Union Switch & Signal Company, the Gould electric train lighting, and the Pyle electric head-light for locomotives. The magnificent engines of most recent types of construction include the Baldwin compound (Vauclain system), the Schenectady and Richmond compounds (two-cylinder systems), and the Brooks' high-speed engines (single-cylinder type).

There are two boiler installations, of a total of 4,000 horse power, for supplying steam for the two power plants, at from 110 to 125-pounds pressure. The boilers are all of the vertical type, fired by the natural gas piped to the Exposition, and using the Kirkwood burners. The gas consumption is about 30 cubic feet per boiler-horse-power hour. The service steam-power plant of the Exposition, as its name implies, is therefore an emergency plant. Its use of new and second-hand engines, without exception belted to new and second-hand dynamos, is not expected to represent latest and best practice. High-speed automatic steam engines, simple or compound, from 100 to 200 horse power, direct-connected to electric generators, are represented by the Straight-Line, American, and Erie Ball engines, in the machinery court power plant. The Exposition strikingly illustrates most recent developments in electrical and gas engineering with their chief applications to power, transportation, and illumination. Two electrical developments here exhibited are specially significant. The electrostatic machine has come out of



THE ELECTRIC TOWER AT BUFFALO, SEEN FROM THE NORTH
Copyright, 1901, by C. D. Arnold



TRANSPORTATION EXHIBIT AT THE PAN-AMERICAN.

the laboratory and the museum to do its share of service. The storage battery has reached into the fields of lighting, transportation, telegraphy, and telephony. The largest single cell in the world is exhibited, of the Gould type, with plates 15½ inches by 31 inches, of total weight of 8,750 pounds, and a capacity of 2,000 amperes for eight hours; while the new Edison cell is placed on exhibition, of 100 watt-hours capacity, weighing 5¾ pounds, with iron and nickel elements in an alkaline solution.

Electrical transmission for exposition power is a marked success. We shall not see again, for this purpose, great central engines with long lines of steam piping and shafting. By electric driving a certain fitness has been readily secured in the location of exhibits as related to their architectural environment. It lends itself admirably to desired interior arrangements and decorative details. Examples are to be seen within this Exposition of the development, transmission, and utilization of power by water, gas, steam, compressed air, and electricity. It is clear that an effort has been made to do the other motive powers justice. But it was practically impossible in such an exposition, where the battle of the motive powers is so unevenly waged beneath the shadow of the Spirit of Niagara.

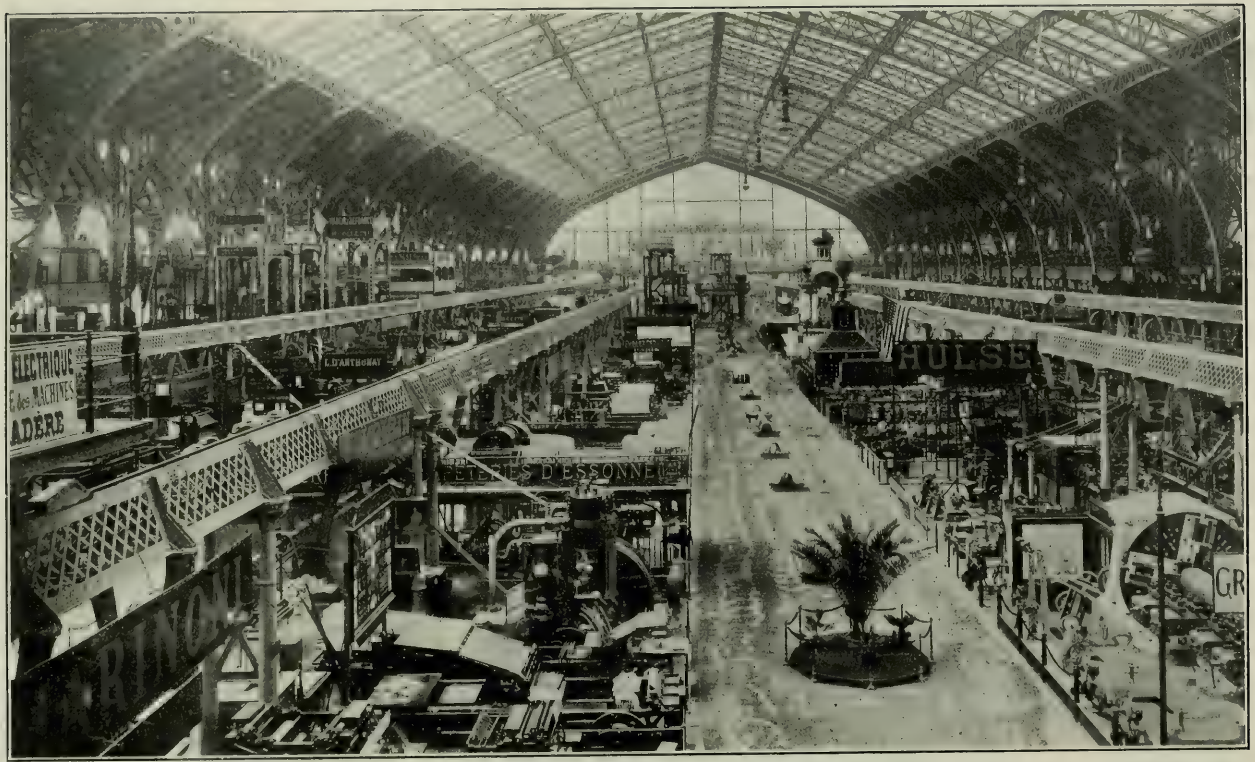
THE ENGINEERING ORGANISATION OF A GREAT EXPOSITION.

By Georges Caye.

Regarded subjectively, the great exposition affords a most striking example of works management on a colossal scale. Power generation, transmission, and application—mechanical transport of persons and materials—lighting, heating, and sanitation—above all, organisation and labour management—all must be ordered with the utmost available wisdom and forethought. Dr. Kerr and Prof. Aldrich have studied the mechanical features of the great expositions now open. M. Caye analyses the internal mechanism of the great Paris exposition itself.—The Editors.

THE remarkable progress realised in all the varied branches of science and industry in the course of the nineteenth century has greatly extended the scope of the work of the engineer. The great increase in the part taken by machinery and the numerous transformations which have caused metal to be substituted for stone, have demanded a much wider range of knowledge than formerly, and continued to compel recourse to numerous expedients, calling in the exercise of much ingenuity and scientific ability. It is therefore altogether intelligible that in the organisation of such an undertaking as the recent exposition at Paris the engineer held a preponderating influence, and it is of interest to examine the various services rendered by the engineering profession, and the manner in which many difficulties were surmounted.

Let us recall the conditions of the organisation of the exposition. Its creation was ordered by the President of the Republic by a decree bearing the date of July 13, 1892; that is to say, hardly three years after the close of the exposition of 1889. This latter exposition had been so remarkably successful that it appeared difficult to think of anything better, while at the same time the desire of France to make the new exposition a worthy apotheosis of the close of the century



THE MACHINERY HALL AT THE PARIS EXPOSITION OF 1889.

This remarkable gallery, 110 metres wide and 420 metres long, remains as a memorial of the Exposition of 1889, and was used for various groups in 1900, the Salle des Fêtes, a large structure in itself, being erected entirely within it, and leaving much room to spare. Two electric travelling cranes of 60-feet span each traversed the entire length of the building, and were used for placing and removing exhibits. The end of one of these cranes is just visible at the left. These were, for the period, remarkable applications of electric driving.

demanded as much time as possible for the elaboration of plans and organisation. Early in 1893, therefore, the administration of the future exposition was started, being placed under the direction of a commissioner general, and to no one could this post have been better confided than to the man who filled it so admirably, M. Alfred Picard, inspector general of the Ponts et Chaussées, president of the section of public works of the Council of State, and secretary general of the Universal Exposition of 1889.

The various departments of the administration were sub-divided as follows:

Secretary General,
Direction of Finances,
Direction of Buildings, Parks, and Gardens,
Department of Roads,
General Direction of Exploitation,
Department of Bridges and Passages over the Seine,
Department of Claims.

In addition to these, there was instituted in connection with the office of the ministry of commerce and industry, a superior commission of the exposition, composed of about 150 members, and including in its membership the most eminent individuals in science, art, commerce, industry, politics, and administration.

Omitting further mention of the purely administrative departments, we shall discuss here the technical departments, properly so-called, in which members of the engineering profession have had to undertake the most difficult tasks, and as the issue showed, in a most efficient and successful manner.

As an example, attention may be called to the part played by engineers in the department of architecture, a department to which was entrusted the erection of buildings and pavilions covering 40 hectares (nearly 100 acres). This department, under the direction of M. Bouvard, director of architecture of the city of Paris, consisted of a great number of architects and engineers, and it is hardly possible to distinguish the one profession from the other here, since the erection of such buildings as were required by the exposition demanded the services of architects possessing practically the training and qualifications of engineers. In addition, the department of architecture commanded the services of a body composed exclusively of engineers.

All the large structures of the exposition really contained metallic skeletons of much constructive importance. The metal frameworks were obliged to support very heavy loads and at the same time to span considerable openings. It was therefore deemed altogether prudent to provide a special engineering department, called the section of structural metal work, which was placed under the direction of MM. Résal and Alby, engineers of the department of Ponts et Chaussées, and designers of the remarkable bridge of Alexander III., a masterpiece of metallic construction which has already been described in The Engineering Magazine by M. Jacques Boyer.*

All the designs for structural work were passed upon by the department, and critically examined before being approved. It was also the duty of the engineers of this service to inspect all the work of the various contractors, following the progress of the buildings step by step, making frequent tests of the actual material employed, watching the character of strength of the scaffolding, and maintaining a general critical supervision of the entire work, from the preparation of the foundations until the completed erection of the framework. All materials manufactured on the grounds were under careful inspection, both as to the quality of original material and to the method of preparation, this being notably the case in connection with the preparation of the concrete for the numerous examples of concrete-steel construction employed.

This unceasing inspection and control was not limited to the work directly executed by the administration of the exposition, but extended also over those structures erected by the public departments, as well as the foreign commissions and the various holders of private concessions. In a word, no building was permitted to be constructed within the limits of the exposition without having been inspected by the engineers of this special department.

The department of architecture had, therefore, to conduct all the tests upon which depended the definite acceptance of all the construction work, and when it is understood that this included, with the buildings erected by others than the exposition administration, fully 60 hectares (about 150 acres) of structures, and the supervision of workshops employing 20,000 workmen, the burden of the task will be appreciated. This commission was also entrusted with the design and construction of the wooden bridges which crossed the main thoroughfares intersecting the exposition at the bridges of the Invalides and the Alma. These structures demanded an exceptional degree of solidity in order to support the great crowds which daily surged over them passing to the Champ de Mars from the Invalides, and from the Champs Elysées to the Trocadero. They were therefore inspected

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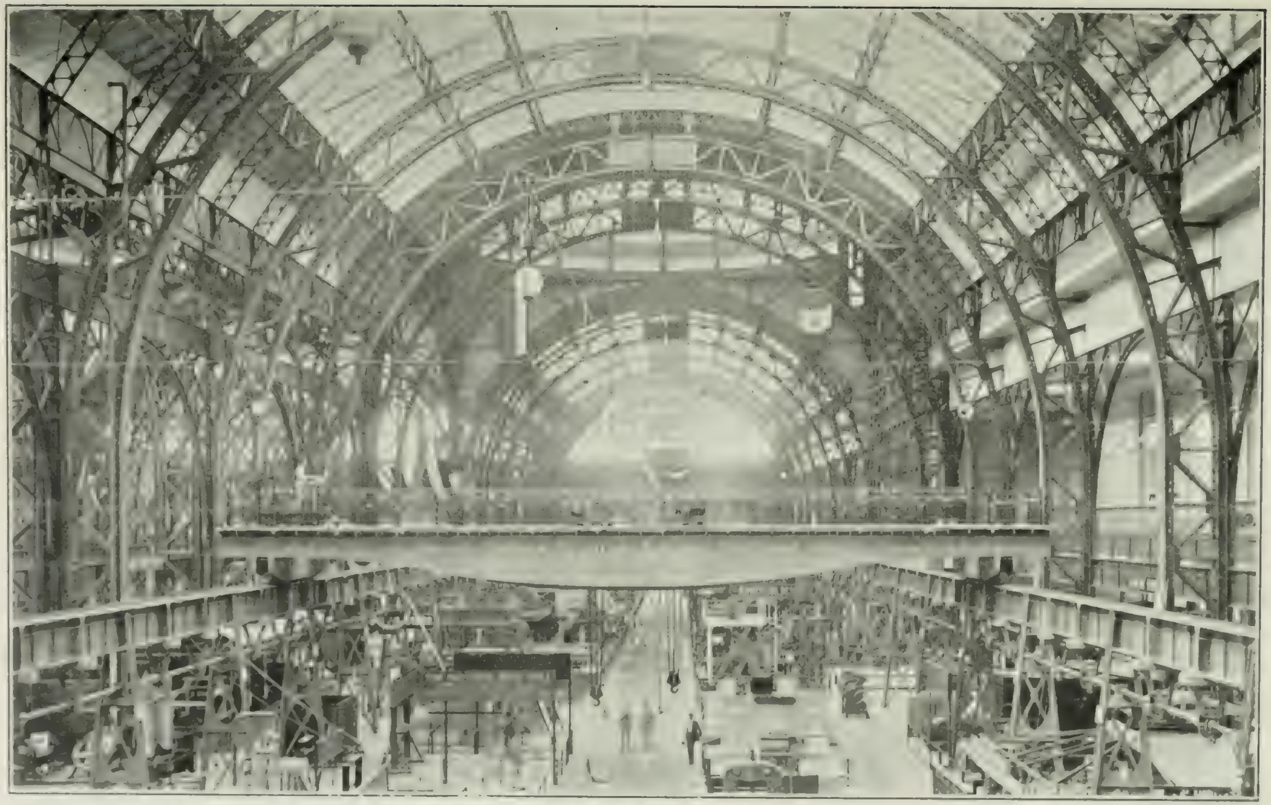
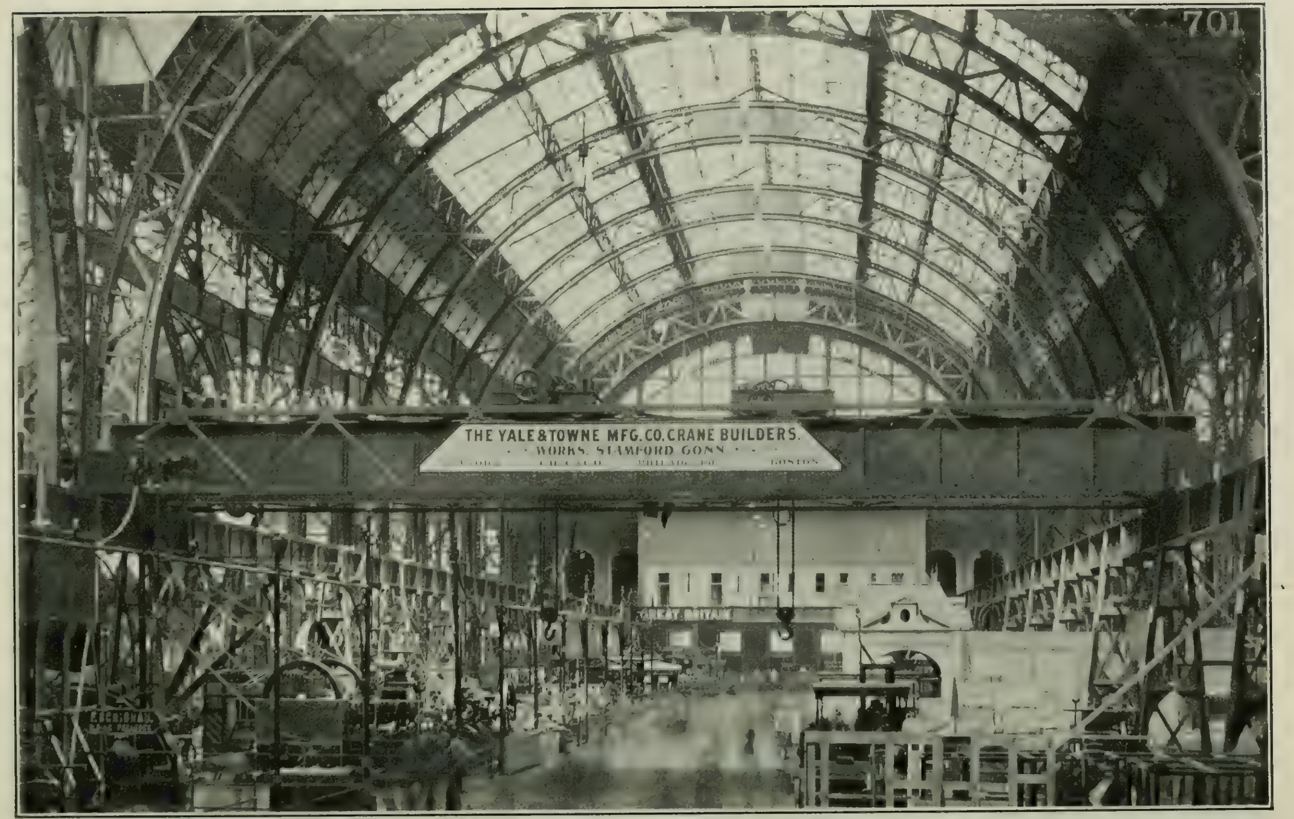
* See The Engineering Magazine, Vol. XVII., May, 1899, page 214.



BAY OF MACHINERY HALL.—CHICAGO, 1893.

Another view showing a second crane. These cranes were fitted with temporary floors during the Exhibition, and carried passengers and bands of music up and down the entire length of the building.



BAY OF MACHINERY HALL—CHICAGO, 1893.

The machinery building at the Chicago World's Fair was in three bays, and following the precedent set at Paris in 1889, electric travelling cranes were erected in each bay, these being exhibits of leading builders. By this means all exhibits were readily installed and removed, and the necessary handling during the Exhibition also accomplished.

with great care during construction, and subjected to numerous and severe tests before final acceptance.

The department of architecture also took charge of all details of construction with regard to a satisfactory degree of safety from fire, fireproof construction being demanded throughout.

The department of roads, entrusted to M. Defrance, director of the services of highways, sewers, water-supply, and lighting of the city of Paris, had in charge the entire system of roads outside of the buildings, parks, and gardens. This included the construction, operation, and removal of the numerous railways intended for the transport of materials of construction and of exhibits, as well as those used in connection with cranes and hoisting machinery.

To this department was also entrusted the arrangement and construction of the foot-ways and roads connecting the various parts of the exposition, including many stairways, quays, foot-bridges and highway bridges. This service included the water supply of the exposition, furnishing both potable and river water from the mains of the city of Paris, not only for drinking purposes but also for watering the plants, supplying exhibitors, and providing defense against fire. This water supply involved more than 1,000 service connections, of which 300 were of large size for supplying steam pumps. The necessity of providing against fire was most important, for, although the buildings themselves were of non-combustible materials, it was necessary to protect the great mass of exhibits with which they were filled.

The drainage of the exposition included an extensive special system of sewers, the flow of discharge water from the 110 hectares (272 acres) increasing daily from the beginning of the works until the close of the exposition. This sewage system was connected with the large collectors of the Paris system, and has been preserved intact for future service.

The department of roads also had charge of the lighting by gas of certain portions of the exposition, both within and without the buildings, in those portions in which electricity was not employed. An important portion of the work of this department lay in the examination of all propositions relating to railways and other installations intended for the transport of visitors within the precincts of the exposition. The projects finally adopted were the moving sidewalk and the electric railway. The latter involved some especially difficult problems, because the line was necessarily constructed partially overhead, partially on the surface, and partially underground. This demanded a number of ingenious expedients which were successfully worked out in consultation by the engineers of the exposition and those of the company holding the concession.

Another delicate undertaking in the control of this department was the control of the thoroughfares parallel to the Seine, these being on each bank, parallel to the quays, and requiring to be kept open to the general public during the entire period of the exposition. Here it was found necessary to construct underground passages on the right bank at the Pont d'Iena, as well as on the side of the Champ de Mars, to enable that portion of the enclosed grounds of the exposition to be traversed. These required the construction of tunnels of more than 30 meters in length, in reinforced concrete.

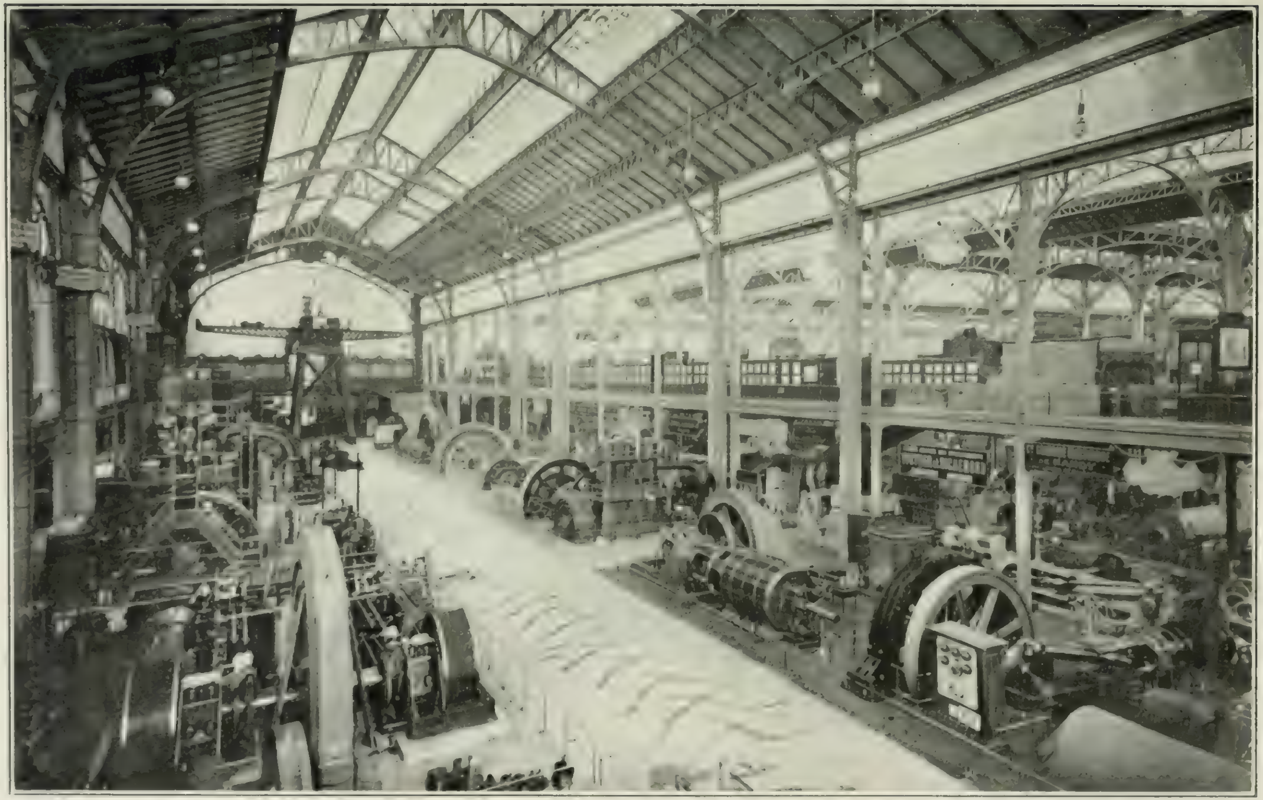
In this connection must be mentioned the bridges and temporary passages, which, at the exposition of 1900 occupied a position of particular importance, and the care of which was entrusted to MM. Résal and Lion, chief engineers of the Ponts et Chaussées.

The expositions of 1878 and 1889 occupied no space on the right bank of the Seine except in the palace and gardens of the Trocadéro connected directly with the Champ de Mars by the Pont d'Iena. The exposition of 1900, on the contrary, extended along both banks of the river, rendering it necessary to provide such communication between both sides as would permit a satisfactory circulation of the visitors.

The grounds of the exposition extended between the Pont de la Concorde and the Pont d'Iena, and the only two bridges crossing the Seine between these could not be utilised without a serious interruption to the regular traffic. It was therefore deemed advisable to construct temporary foot bridges by the sides of these two bridges, in addition to which the Pont d'Iena was provided with temporary sidewalks on each side. In addition to these an important temporary bridge was constructed across the river between the Pont d'Iena and the Pont des Invalides. The most important structure in the hands of this department, however, was the remarkable and beautiful Pont Alexandre III., to which reference has already been made.

The department of the administration entitled the general direction of administration was placed under the direction of M. Delaunay-Belleville, civil engineer, and honorary president of the chamber of commerce of Paris. M. Stephane Derville, former president of the Tribunal of Commerce of the Seine was made adjunct director general, having special charge of the French section.

The work of this department may be classed in two distinct categories: the administrative service and the technical service.



FRENCH END OF POWER-GENERATING SECTION—PARIS, 1900.

Nearly all the engines exhibited were connected directly to the electric generators, usually in large units, and the Exposition was notable for the absence of shafting and belting transmission. The cantilever crane seen in the distance travelled on rails laid beneath the flooring, and was used before and after the Exposition for handling exhibits.

The former included the formation of the departmental committees—the committee of admissions, the committee of admission of exhibitors, of installations, of distribution of space between exhibitors, and between nations, the formation of classes and groups (subject to the commissioner general), of control of receiving and delivery of exhibits, and of their protection, and of the constitution of juries and the distribution of awards.

The technical service, entirely confined to engineers of acknowledged reputation, had charge of the production and transmission of motive power. The system of classification adopted, being based upon the placing, for each industry, of the raw material, the process of manufacture, and the finished product in close proximity, made it no longer possible to follow the plan adopted in 1878 and 1889, of providing a great machinery hall for the motive power and the operating machinery. On the contrary, all the boilers and engines had to be placed in special galleries, the whole constituting a great central power house, from which energy could be distributed to all parts of the exposition. Under these conditions it was manifestly impossible to think of employing transmissions of shafting and belting, and recourse was had to electricity. In this respect the exposition became a most characteristic illustration of the progress made since 1889, showing as it did the important service rendered by the development of electric transmission of energy.

All the motive-power machines, therefore, appeared as generating sets in which the dynamos were mounted directly upon the engine shafts, either replacing or supplementing the fly wheels. The principal subdivisions of the technical department of the administration in this work were: the service of mechanical installations, having in charge the production of motive power; the service of electrical installations, controlling the distribution of current for electric power and lighting; and the service of handling, having in charge the erection and moving apparatus.

The service of mechanical installations was placed in charge of M. Ch. Bourdon, professor at the Ecole Centrale des Arts et Manufactures, he having also had charge of the mechanical and electrical service at the exposition of 1889. There was also a consulting commission, called the technical committee, consisting of sixty-one members, leaders in the scientific and industrial world, and presided over by M. Linder, inspector general of mines and former president of the superior council of mines. This committee was divided into three sections or sub-committees, upon boilers, engines, and miscellaneous machinery; these being intrusted with the elaboration of the details involved in the production of 36,000 horse power by steam machinery. The steam boilers were required to furnish steam at a uniform pressure of 11 kilogrammes per square centimetre (156 pounds per square inch), at a rate not exceeding 600 kilogrammes of steam per square metre of grate per hour, (about 123 pounds per square foot of grate). The exhibitors were to receive, as compensation for the expense of installation, an indemnity of 1,500 francs per 1,000 kilogrammes of productive capacity per hour, in addition to the sum of 4fr. 45c. per 1,000 kilogrammes of steam produced. The sub-committee was entrusted with the examination of the various plans submitted by the exhibitors, with power to decide the evaporative capacity to be allotted to each boiler.

There were installed 92 boilers, of which 74 were multi-tubular, 4 semi-tubular, 6 Galloway, and 8 Cornish. In this connection it may be of interest to compare the advance made in the size and evaporative capacity of steam generators since 1878.

Exposition.	No. of Boilers.	Daily Evaporative Capacity.
1878	19	219,450 kilogrammes
1889	30	382,205 " "
1900	92	1,500,000 " "

The quantity of combustible consumed during the exposition reached 200 metric tons per day, and to enable this amount to be handled there were installed two tracks connecting with the railway station of the Champ de Mars, and extending throughout the length of the two galleries in which the boilers were placed. Each morning the cars brought in the supply of coal for the day and removed the ashes and cinders of the previous day, the whole occupying but a brief space of time. The service of mechanical installations also had charge of the design and construction of the flues by which the gases of combustion were conveyed to the chimneys. The two great monumental chimneys provided, one for each gallery of boilers, were constructed with especial reference to the removal of the gases without the production of any objectionable effects in the neighbourhood. It was also essential that the chimneys should harmonise in appearance with the structures on the Champ de Mars, and the final designs were selected as the result of a competition in which eighteen projects were submitted.

Having thus provided for the installation of the boilers and the generation of steam, the distribution to the various engines demanded attention; and this problem involved the design of an important system of underground passages. The entire system of underground galleries formed a total of 1,500 metres in length, the passages being 2.7 metres high and 2.6 metres wide, providing for the passage of 1,500,000 kilogrammes of steam at a pressure of 10 kilogrammes per square centimetre (142 pounds per square inch) and 35,000 cubic metres (1,236,000 cubic feet) of water per day. The steam was carried in mains to which the feed pipes of the engines were directly connected. Since the public were admitted freely to the boiler houses, walking directly upon the covering of the underground passages, it was necessary to take the greatest precautions that no accidents should occur.

The installation of the generating sets was conducted under the joint supervision of the services of mechanical and of electrical installations, the latter being under the direction of M. R. V. Picou, president of the Société Internationale des Electriciens, and maitre de conferences at the Ecole Nationale des Ponts et Chaussées. In addition there was an electrotechnical committee, consisting of forty-two members, presided over by M. Mascart, Member of the Institute, this committee having charge, in conjunction with the sub-committee on engines, of the various questions arising in connection with the production, distribution, and utilisation of electrical energy. These two committees selected MM. Hirsch and Potier to examine the proposed projects in detail.

The generating sets adopted were arranged in two galleries, parallel to those containing the boilers, one gallery being reserved for the French exhibits and the other for those of foreign countries. As with the boilers, it is interesting to compare the number and size of engines with those at previous expositions:

Exposition.	No. of Engines.	Total H. P.	Average H. P. per Engine.
1878	41	2,533	62
1889	32	5,320	166
1900	37	36,085	975

At the exposition of 1900, seventeen generating sets, representing a total of 13,200 horse power, produced continuous current, while the balance generated alternating and three-phase currents. As in the case of the boilers, the constructors of the generating sets received indemnities for the cost of installation and the expense of operation. The amount paid out by the administration for this purpose to the French and foreign exhibitors attained the sum of 800,000 francs.

The distribution of the electrical energy was entirely under the direction of M. Picou. This was a delicate and difficult problem, especially in view of the variety of motors employed and the different kinds of current generated. The continuous current, having a low voltage, was necessarily used near the place of its generation. It was therefore employed for the transmission of energy and for illumination within the limits of the Champ de Mars, at a pressure of 220 volts, and at the Invalides for motive power only at a pressure of 500 volts.

In the case of the alternating currents, it was deemed advisable to arrange the service in such a manner as to permit any motor, in case of accident, to be replaced at once by another. For this purpose the exposition was divided into sections, each section being supplied by a special current corresponding to a group of generators having the same general characteristics, and producing currents of the same character, voltage, and frequency.

As the exposition was open in the evenings, the electric lighting became a matter of importance, the total radiation of the electric lamps representing about 7,000,000 candles.

The service of handling was placed in charge of MM. Guyenet and Ringuier, and included the moving and placing of the exhibits, as well as the materials of construction. It was found necessary to establish a complete system of railway tracks upon the exposition grounds, the exhibits arriving both by railway and by boat. Powerful hoisting devices were necessary for handling the heavy masses included among the exhibits in the sections of machinery and metallurgy. The latter section was provided with two electric cranes of 25-tons capacity each, capable of being operated singly or together. A temporary flooring was placed in the building for the metallurgical exhibits on the Champ de Mars, and although this flooring was very heavy and strong, the weight of some of the exhibits was so great as to require it to be especially strengthened in certain parts to carry the great local load.

The heavy exhibits arriving by water were unloaded by means of powerful cranes on the Quai d'Orsay, one at the Pont d'Iena being of 45-tons capacity, the other at the Pont d'Alma of 30-tons, the latter being operated by a petroleum motor. In the galleries containing the engines and electric generators were two powerful hoisting machines, a Titan crane of 45-tons capacity being in the French section, and an electric gantry of 25-tons in the foreign section. Besides these large machines many smaller hoisting machines of various kinds were scattered throughout the exposition. An idea of the importance of the service of handling may be obtained when it is understood that the heavy pieces in the department of metallurgy alone represented a total of 75,000 tons, of which 40,000 tons were delivered by railway and the remainder upon trucks.

It may be remarked that this service was especially well conducted, being the only one which was ready at the date fixed for the opening of the exposition, and unlike the other departments having done no night work.

The service of handling, in addition to the duties already described, took charge of the numerous elevators, travelling stairways, etc., connecting the ground floor with the numerous overhead galleries.

Finally we may mention the service of hydraulic installations, in charge of M. Meunier, and charged with maintaining a supply of water for the Chateau d'Eau and for the feeding of the boilers. The necessary supply was taken from the Seine below the Pont d'Iena and delivered by an important pumping station. After being used the water was returned to the river, this involving a double system of pipes, which, together with the pressure of water offered a considerable resistance to be overcome.

Such was the broad outline of the service of an exposition involving the services of fully 5,000 men.

All these various services, instead of being scattered over the exposition, as in 1889, were grouped in a special building, erected on ground temporarily acquired near the exposition, where formerly had stood the imperial stables. This building, covering an area of 6,124 square metres, was designed by M. Deglane, the architect of the large palace of the Champs Elysées, who acquitted himself most creditably of this thankless task, for which the meagre sum of 400,000 francs only was allowed. This grouping of the headquarters of the services presented many advantages, resulting in a material saving of time in the communication between the various departments, and above all, in producing a homogeneity most beneficial to the progress of the work.

In concluding, we may be permitted to render a final tribute to the many eminent men, who, in spite of the inevitable misunderstandings and difficulties of such a vast undertaking, succeeded in giving us such a grandiose and at the same time fairy-like exposition; a veritable apotheosis of the century which has closed and at the same time a brilliant dawn of the century just opening.

AMERICAN MACHINE-SHOP PRACTICE FROM A GERMAN VIEW-POINT.

By Peter Lüders.

Mr. Lüders' estimate of American practice represents the conclusions of a thoroughly practical man, master of the machinery and tool-making trade in Germany and minutely familiar with its technical and economic aspects. His American experience was gained during an extensive tour of the United States in a semi-official capacity. An unprejudiced view of this sort, given by an outsider, is highly valuable at a time when American competition in European markets is attracting so much attention. Mr. Lüders' second paper, treating specially of standardisation, will appear in our next issue.—The Editors

IN the papers upon "Machine-Shop Management in Europe and America," published in The Engineering Magazine, 1899, Mr. H. F. L. Orcutt, referring to the large amount of American machinery purchased during recent years by European and especially by German manufacturers, says:

"The large quantity of American machinery now being sent to European countries indicates that there is something in American machine-tool practice and design which is desirable to European manufacturers, and cannot be secured from their own makers of machinery. Why is it that the European manufacturer is buying so largely from America? How is it that the American machine-tool maker can send machinery abroad, pay freight and duty, and compete with the European maker? It is important for both sides to understand the situation; on the one hand, for the European to select that which is good in American practice, and to adopt it as far as possible, on the other hand, for the American maker of machinery to know where his practice differs from the European, so that he may adapt his methods as far as desirable to European demands."

"It is important to understand the situation." Nothing seems to be easier to get than this understanding, and very likely most of the engineers on both sides will consider it to be so. But anyone who has been once in America and found sufficient time and opportunity to become familiar with American machine-shop practice and American manufacturing conditions, will not hesitate to say that there is hardly anything more difficult than the acquirement of a real understanding of the situation on both sides.

The problem is a much debated one, and a great number of writers have undertaken to state the differences between the works and their equipment in Europe and in America, and to show the rules for the general management or the system of an American machine shop, and have advised the selection and adoption or the simple copying of that which is good in the practice of one or the other of the two countries. But the why and the wherefore which brought about these differences are left quite unconsidered, certainly so far as employer and employee, that means as engineer and workmen, are concerned. And so if all these points of physical difference be noted as clearly as possible, not only for a machine-tool factory as Mr. H. L. F. Orcutt does in the paper mentioned above, but for every works no matter in what line—no branch left out, every department mentioned with all its details—there will nevertheless still be left unconsidered many features far more important than all these counted. These deeper-lying matters may seem to have no connection at all with machine-shop management or the manufacturing system itself, with the increasing or decreasing demand for the manufactured articles, but they are there and they must be taken into careful consideration if a good understanding of the situation is to be reached. The first study, therefore, may be of the mechanical engineer and the prominent part he has played during the last few years of enormous progress.

Not only by the new machine tools or the use of time- and labour-saving machinery, not alone by the separation of the different departments or the employment of low-wage workers on the one hand and of a number of highly skilled foremen or tool-makers on the other hand, nor yet by the erection of well and hygienically designed works nor by the immense advertisement business done all over the world, have American works and their products been brought to the perfection they have reached now. No; all these things are themselves only consequences, and by no means the first reason that American machinery has become an everywhere-demanded product. The question how this result has recently been achieved is a very important one for the whole industrial world.

Before the Americans undertook to understand the situation on the other side of the ocean, they began by understanding the situation at home thoroughly. They recognised that a real success would only be obtainable where theory and practice—or, even better, engineer and workmen—would work together hand-in-hand. They learned that there could be no separation at all of these two factors, and that the opportunity for the exercise of judgment was in determining where and how far practical knowledge needs the grasp of theory to design a good and universally demanded product. But the Americans did not stop at this point; they let the deed instantaneously follow up the thought. The engineer ceased to tower hundreds of yards above the workman, thinking his own knowledge much superior to the man beneath him. He recognised that his work would be only half if he did not co-operate with the workman, and so he tried to become the head for him. The workman then gave the hands. Thus theory and practice, engineer and workman, idea and realisation, came together and the result was what we see and study now in America and what the most of the German engineers like to call, with absolute non-comprehension of the situation, the result of the "*Amerikanische-Ingenieur-geschicklichkeit.*"

I believe this unity of the engineer and the workman to be the most important part of the whole explanation how the American machinery trade could develop so marvellously in such a short time as three or four years. I shall endeavour to give in this paper an idea of how this could be, that is, how engineer and workman in drawing-room and machine-shop must bring together their ability, their knowledge, their experiences, to create the best possible results—commercial, technical and practical—as is now the case in America.

The commencement, therefore, is the absolutely free intercourse of ideas and experiences throughout the staff in general, and further between the chief engineer and his draughtsman, which is never hampered by any professional jealousy. The chief engineer certainly takes the main responsibility for all construction work, and he would lose his place as the consequence of any mistake at all important to his firm. But he does not fear this responsibility, feeling it to be the only thing that can give him real interest in his work, and knowing that his greatest help and his best protection against any possible failure will be to give a share of his responsibility to his draughtsmen, that is, to interest these men personally in the work given to them. Therefore he proceeds to teach his men, to show them how to get out the best, the cheapest, and at the same time the most economical constructions. Let them thus learn how he works, let them follow up his ideas and use them later on wherever they like; to-day he is working for this firm, these men are given to him to help him, and he could do nothing more foolish than to go his own way, careless of all others in his office, believing them much too narrow-minded to understand him or thinking himself far more clear-headed than all his men together. He knows that his work can be a successful one only if he understands thoroughly how to use his men's brains always and everywhere, *and that policy he never forgets.* Some people will certainly say these ideas are just as selfish as every American is. May be; but the draughting room is not the place to dispute about feelings and other things of that kind; it is the place where the most important part is done to secure a success for the whole works by increasing the capacity and application of every constructed machine and by producing every day work more fitted to prevail in the world-wide competition. The chief engineer may be as clever as possible, as broad-minded as imaginable, but he will never be a *good* chief-engineer if he does not take the greatest care for every detail of his own constructions as well as those of his draughtsmen and does not force his men as well as himself always to find, for every construction, the simplest method of production. But if that is to be obtained, it is absolutely necessary, as already stated, on the other hand, to have the hearty co-operation of his men, on the other hand to specialise himself.

These two facts the Americans have fully recognised and the result shows that they know how to get the best out of their recognition. The best and ablest men and the largest manufacturing concerns confine themselves to the study of one class of machinery only, trying to bring this to the highest grade of accuracy and application, altering and modifying drawings and patterns over and over again until the best, the cheapest, and the most economical machine, for the builder as well as for the buyer, has been secured. And the end of all this work, of the enormous amount of energy and capital employed therein, is the system of specialisation and standardisation, which now generally characterises the entire American industry.

German engineers as a rule do not believe in this kind of friendly co-operation, relations of the chief engineer toward his draughtsmen in respect of knowledge and standing being mostly the same as those of the officer to his common soldiers. Still less do they study American specialisation and standardisation, generally believing it necessary and useful for every one else except for themselves. Certainly no one who knows Germany and America and who has any understanding whatever of the situation on both sides of the ocean can advise German concerns to proceed immediately to specialise their business as far as the Americans have done, particularly if he cannot give them at the same time an understanding of the very great importance of free intercourse and unhampered co-operation between the chief engineer and his men. But before that would be possible a complete revolution of nearly everything connected with the German engineer and engineering business would be necessary. At present nearly every one of them believes himself worth nothing if he does not figure out a new construction, no matter for what kind of machinery. He must have his patents, he has to show the world that he is a man who does not depend upon the knowledge of all his forefathers, and he must be as much as possible an all-around engineer. And this conception makes it possible for an engineer to advertise himself, as I actually saw lately in a German technical paper, as "a most able man not only for general steam-engine constructing and manufacturing business and for the building of brass and every other kind of foundry, but also for the construction of flour mills, grain elevators, storage houses, steam brick kilns, pottery works, apparatus and fixtures for breweries, beer cellars and beer filters of the latest style, mills for grinding gypsum and cement, hydraulic presses and high-pressure pumps, bar pumps, air compressors, cranes, elevators, and agricultural machinery." He must have been an "all-around engineer," but not one who could give any really good advice in any special case, even in one of the lines he thought himself especially fitted for.

It may be that under this kind of working there have been brought forth a number of good and theoretically fine constructions, but that is of very little value compared with the results which could have been obtained if most of these men would have used their ability to perfect preceding work instead of ignoring the experiences of all their forerunners. So they create the most complicated constructions, maybe to spare one-quarter of a pound of coal under the boiler or steam in the engine, making their firms therefore pay out enormous sums of money, never realising that the best construction is useless if it does not mean at the same time improvement in competitive position. But if German engineers would recognise that fact they would have the same success with their works as has been realised by any of the great American firms who have attained international reputation. At every one of these places there is specialisation, but in moderation—just enough to get the best of everything, but not necessarily so much that only one kind of machinery is built.

Cramp's works I believe to be the nearest approach in general character to the so-called German steam-engine works, but I think far better managed in many points. This establishment shows that between keeping to the old style of doing business and the latest and most extravagant kind of American specialised works there are many good means worthy of adoption. If these are considered and employed at the right place, the result would prove very soon that the best German engineers and manufacturers can do, to get out work a good deal cheaper, more uniform, and with quicker deliveries, would be to follow up some of the methods used with great success in these American shops. So the engineer and manufacturer could help to bring about quite a new era in the German machine business. But unfortunately it does not depend only upon them.

There is still one factor more, and to modify that the change would have to be far greater than for the engineer. If the engineer believes himself to be the only one who knows anything about machines, the man who intends to order a machine knows far more about it. He will not come and tell the manufacturer that he needs an engine for so many horse power and for such a kind of work. No; he writes a complete book called *"Bedingungen,"* and this book serves only to cripple to the greatest extent energy and enterprise, compelling the manufacturer constantly to follow the caprice of one customer after another; he has no opportunity whatever even to classify and utilise the informations that he picks up from experience as he goes along, as Sir Benjamin C. Browne says in his articles in THE ENGINEERING MAGAZINE on "Standardising in Engineering Construction."*

So far I have considered only the hearty co-operation of engineer and workmen, or the union of theory and practice, as a reason for the enormous progress the American machinery trade has made during the last few years. But besides that cause there are a great number of others, not less important or interesting, which brought that state about. These may all be taken together under the headings of "specialisation and standardisation."

Nearly everything the German engineer will find new and interesting when visiting American works can be placed under this heading, these two words and their meaning containing the summary of all that American ingenuity has accomplished during recent years. And the treatment of these two headings will, on the one hand, show most clearly where American engineers and manufacturers have manifested their excellent comprehension of the world's needs and requirements, and, on the other hand, will let the German engineer and manufacturer discern where he may learn something for his own profit. The detailed exposition of the system of specialisation and standardisation as it affects the practical conduct of the works will be taken up in a succeeding article.

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* THE ENGINEERING MAGAZINE, Oct., Nov., Dec., 1899.

THE CHOICE OF AN ELECTRIC-POWER DISTRIBUTION SYSTEM IN FACTORIES.

By P. R. Moses.

The views from the Glasgow and Buffalo Expositions shown in the first part of this Magazine, as well as the illustrations taken from the Paris Exposition of 1900, suggest the wide extent to which electricity has supplanted wholly mechanical systems of power application. Mr. Moses assumes as his starting point that only the manner of its use remains open to debate. Not the least interesting point he makes is that the increased efficiency of the use of human energy secured by electric driving is really the main cause of its success. He makes an able plea for the system which he favors, but admits freely that other methods have strong advocates. The Magazine will be glad to afford to any debatant of the question an equally full opportunity to argue his view of the case.—THE EDITORS.

THE question of the advisability of the electrical transmission of power in factories and mills may be regarded as decided in the affirmative, and with the exception of some machines essentially compressing or reciprocating in their action, such as riveters or hydraulic presses, the electric motor operates the machine to be driven directly, through belt, gear, or shaft, without the interposition of any fluid or gas capable of storing power. Until the beginning of the present boom, however, electricity had a hard struggle to hold its own against compressed air and other methods of transmission having the "talking point," as it may be properly called, of storage of energy. In fact, until Mr. Gano S. Dunn and some others showed how small the question of cost of power was compared to its ease of application and regulation; until manufacturers and mill owners had been forced, by the immense influx of orders involving immediate addition and changes to existing plants, to realize the advantages of a system absolutely flexible in its character as to speed of operation, location, or capacity for enlargement; until the electric motor had become, through many years experimenting by the most skilful engineers of the country and immense investments of capital, a standard manufactured article reliable and replaceable in all its parts; until, finally, the money was available with which to install the electrical apparatus on a proper scale—the electrical method of power transmission was fighting for supremacy. Now that it has found its place at the top, its advocates, like the members of the ancient church, have fallen upon each other, and the cries of alternating *versus* direct, or of 500-volt *versus* 250 or 125-volt transmission, are as strong and enthusiastic as were those of the air and kinetic power advocates in former times.

This question has been brought up more frequently and ardently within the last two years than before, owing to the increased perfection of the alternating, or to be more exact, the polyphase alternating, motors and systems, caused by the enormous development of long-distance-transmission plants, and the desire for uniformity coupled with the excessive competition in direct-current apparatus, obliging the large electric companies to look for more exclusive fields. To these causes chiefly may be ascribed the rise and the development of the two- and three-phase alternating-current generator, motor, and system; a rise which has been almost as rapid as that of the trolley-car or bicycle industry.

It is purposed in this article to discuss the merits and demerits of this system in its application to mills, factories, and buildings, and also to discuss another important general question, viz., the question of the best electrical pressure at which to transmit the power. There is not quite as much discussion of this point as of the other, nor is the question one of as great importance, but the cause of the decision as to advisable pressure has a large bearing on the advisable current and is therefore interesting. Before entering into details it will be well to review the reasons for the success of electric transmission. In the first place, electric motors supplanted small steam engines for driving groups of machines through counter shafts, on account of the absence of steam pipes, cleanliness, noiseless operation, superior speed, regulation, and higher efficiency. These were the first causes; after these, the smaller floor space occupied, the capacity for protection of machinery, and the ease of removal were all recognized as material advantages.

In the second place, the electric motor for individual machines has supplanted, notwithstanding a higher first cost, the group drive with overhead belts and shafting, except where a number of very small machines are driven, because it allows individual and gradual speed regulation of the machines, reduces the number of links liable to fail in the chain of power transmission, gives good light, permits the extended use of overhead travelers or cranes, and allows each machine to be set in the best available position at any angle or, as is the case in some steel-construction works, allows the machine to be set upon a turn table. In other words, it makes each machine an independent entity provided with a motor suited to its individual needs. It is this independence, I am informed, that has led the United States Government to provide every machine in its printing-office addition with an individual motor, extending this practice down to small sewing and ruling machines requiring but a fraction of a horse power to drive them: and this has been done, although the group drive for the small machines would have been more efficient, and probably less bothersome to look after and very much less in first cost.

The advantage, and one beside which the disadvantages sink into insignificance, lies in the fact that each machine can be driven at the speed best suited to its operator and to the work it is doing. Besides this, the ability to place the small machines at varying angles according to their location in respect to windows is important, as is also the facility of removal, should a rush of other work require the space. It may be said that the increased efficiency of use of the energy contained in steam, which was the main argument advanced for the adoption of electric group drive, has become insignificant compared to the increased efficiency of the use of human energy obtained by the direct-connected electric motor. Having these reasons for the adoption of electric transmission clearly in mind, the question of alternating *versus* direct-current transmission may be intelligently discussed. The best system in general will be that which will be free from breakdown, able to stand hard usage and frequent sudden overloads, simple and safe to handle, with parts standard and available. It should be uniform and applicable to all the requirements liable to arise in the work contemplated, the speed of the motors should be variable at will of the operator, and in some cases, like hoisting, should vary inversely with the load to prevent undue use of power. The motors should start with small currents and should have high efficiencies at average loads. The first cost should be as low as possible and the number of parts a minimum.

The alternating two- or three-phase system at low pressure (500 to 220 volts) meets the first few conditions slightly better than the direct-current system of the same voltages. This system consists of a polyphase generator composed of a stationary and a revolving part, an exciter, sometimes revolving on shaft, sometimes belted to shaft, for delivering the current required to magnetize the fields, a system of distributing wires and motors frequently built without brushes, but sometimes, where adjustable speed and good dynamo regulation are required, with brushes and collector rings. The system is simpler than the direct-current system, in that no current has to be delivered to any moving part of the motors. In the direct-current system, current must be delivered to the rotating armatures of the motors through brushes of carbon and commutators made up of copper bars held firmly, clamped by a collar, with mica between the bars and between the bars and collar. This commutator is the chief difference between the motors of the polyphase alternating systems and the motors of the direct-current systems. The connections to the commutator and the commutator itself are the only parts of the motors in which trouble is liable to arise, with careful construction, and, although probably a hundred thousand are in use daily and the manufacture has been carefully studied, trouble does arise; generally on account of accumulation of grease or dirt, allowing the current to jump from the copper bars to the iron frame of the machines, or from breaking of connections between winding and commutator lugs, caused by frequent stopping and starting combined with overheating and slow cooling. This alternation of heating and cooling causes the copper to become brittle and, unless the connections are made flexible, to break off.

The advantages of simplicity, durability, and freedom from breakdown, therefore, are, with the alternating polyphase motors, more especially of the brushless type; but unfortunately for the polyphase system at the present day, all the other requirements are much more easily and better met by the direct-current motor.

The alternating-current system is not yet fully standardized, but is constantly being perfected and broadened in its scope. Its parts are obtainable from but two or three first-class companies; it is not applicable yet to charging storage batteries, to railroad work, or to hoisting, although it has been used for both the last; the speed of motors is not adjustable unless the brush and collector-ring type is used; the starting currents under load are large, causing more or less fluctuation in lights; and the first cost of dynamos and motors is between 25 per cent. and 35 per cent. higher than that of direct-current apparatus of the same capacity. Therefore, unless the value of adjustable speeds, 25 per cent. less first cost, higher average efficiency, etc., are balanced by the possibility of commutator troubles, the direct-current system is at present preferable and advisable for ordinary cases of factory transmission. In such cases the polyphase alternating current's value is confined to the transmission of power from distant sources at higher pressures. In special cases the alternating-current system may prove advisable even for medium distances. One of these instances is in hat, candy, or similar factories where electricity is largely used for heating as well as for power and for light; the ease with which an alternating current can be transformed—*i. e.,* small quantity at high pressure changed to large quantity at low pressure, or *vice versa*—gives this system the preference, as quantity and not pressure is the essential feature of electric heating. Works where naphtha or other explosive gas is used require a sparkless motor, and the alternating motor is the only one fitted for this use. Machine shops with a number of small scattered machine tools may be better suited by one system or the other, depending on the question as to the advisability of direct connection of tools, the amount of probable overload, and the question of speed variation. In mills, large machine shops, and factories of all kinds where the power to transform is not valuable, there is no benefit to be derived from the polyphase current sufficient to offset the disadvantages mentioned.

As to the best pressure to be used for transmitting direct current, the answer cannot be so definite. The advantages of a high transmitting pressure, such as 440 to 500 volts, are low first cost and small bulk of wiring, switches, and controlling apparatus. The disadvantages are increased liability to ground, danger of shock, increased number and decreased size of field armature wires and of commutator bars. The liability to ground may be guarded against in the construction, but the other difficulties are inherent and are sufficiently objectionable to make the 500-volt motor and system inadvisable, except for such purposes as electric railroads where power has to be transmitted a long distance. The 220 to 250-volt motor has only half as many commutator segments, armature conductors and connections as the 500-volt motor; and the 110 to 125-volt motor but one-quarter the number. The sizes of these parts increase in proportion to the decrease in number; hence, the lower the voltage of a motor, the more substantial and the stronger mechanically. The lower voltage offers the advantage, too, of decreased tendency of the current to jump to the frame or from one wire to another. The winding of the fields of the 120-volt motor is made up of less than one-half the number of turns used in the 240-volt motor, and while the wire has twice the area, it does not occupy twice the space; on this account the field coils of the low-voltage motor do not heat as much as the higher-voltage motor. On the other hand the resistances used to control the speed and starting current, the switches, fuses, and the wiring are much larger and heavier for the 120-volt motor than for the 240-volt motor, and for motors of large size this is a decided disadvantage, as it interferes with ease of regulation and control and increases the first cost.

For small motors, 5 to 50 horse power, for transmission over short distances (from 200 to 400 feet), and for fluctuating work, such as elevators, presses, cranes, punches, etc., the 125-volt two-wire system seems preferable. For large motors, transmission over comparatively long distances, or for steady work, where mechanical strength is not essential and where the motor will receive attention, as in silk mills, carpet works, etc., or for work where minimum weight and size are important, the 240-volt system, or one of higher pressure, is usually the best fitted for the purpose.

The lighting of the factory or mill has an important bearing on the choice of pressure and system. At 240 volts, arc lights do not give thoroughly satisfactory results, even when coupled together in series, and the incandescent light at this pressure uses one-third more current, costs one-third more to buy and to operate, and has a shorter life than the 120-volt lamp. It is my practice, therefore, no matter what pressure is used on the motors, to use 110 to 125 volts for lighting. Where the motors operate at 125 volts or less and are of small size, the lights can be taken off the same wires as the power without annoying fluctuation, provided the mains are correctly designed. Where the motors are large and operate at 125 volts or less, a separate two-wire circuit for lighting is all that is necessary. Where the motors operate at 220 to 240 volts, there are several methods of getting 110 to 120 volts for lighting. The one generally used up to the last few years, and still very largely adopted, was to run two dynamos, each generating a pressure of 120 volts, in series, and let these feed a three-wire system, in the same way as the Edison Company adopt for city distribution. The same result is obtained by using one dynamo with two commutators. Another method, which seems preferable for factories where the load can be closely balanced, uses the three-wire system of distribution, but the dynamos operate at 220 to 240 volts, and the current for the middle wire of the three-wire system is supplied by a small motor-dynamo, the capacity of which need seldom be over 5 per cent. of that of the main dynamos, as it only counterbalances the amount of unbalancing of the three-wire system. This system allows the plant to have fewer units and to use each unit to its best advantage.

A method recently adopted, and installed, I think, for the first time in the United States in the South Station of Boston, was originally invented by Dobrowolsky of the Allegemeine Electricitäts Gesellschaft, about twelve years ago, and has a great deal to recommend it, and will, I am confident, be largely used as it becomes better known. The three-wire system is again employed with dynamos operating at 220 to 240 volts, but in this case no auxiliary moving apparatus is necessary. The current for the middle wire is supplied from points in the winding, midway between the brushes of the dynamos themselves, through collector rings, the same as those used for alternating-current generators. As the current in any dynamo is alternating originally, the current for the neutral wire is supplied first from one side of the dynamo and then from the other, keeping the armature circuits balanced and supplying current to the neutral wire. This method will work and will supply the current required, in practice, by the unbalancing of the lighting circuits. There are, of course, many other ways of supplying the lights, and in some instances it may be advisable to run a separate engine and dynamo for lighting alone, but this is not generally the case.

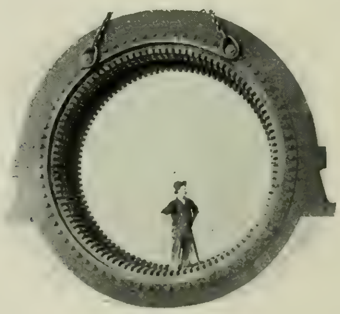
Where polyphase induction motors are used, low-voltage (125-volt) motors offer no material advantage to offset the disadvantage of heavy wiring and controlling apparatus. If the motors are small and in such a position as to place the employees in danger of contact, a voltage of 220 to 250 should be used; otherwise a voltage of 500 is usually employed. Larger motors are run at from 500 to 3,000 volts, depending upon circumstances. The question of frequency, *i. e.*, the number of alternations per second, in polyphase work is of greater importance than that of voltage. Here again there is a conflict between first cost and best operation. Generators and transformers are smaller and cheaper at a frequency of 120 cycles per second than they would be with a frequency of 60 cycles per second, but the losses and troubles from induction would be much greater and the regulation with a heavy motor load would be bad. On the other hand, a frequency of 40 cycles or less per second gives unsatisfactory lighting service, and the motors and transformers are somewhat heavier and more expensive. A frequency of about 60 cycles per second gives good lighting results, both arc and incandescent, and, as the induction effects are not excessive, permits fair regulation. The lighting circuits will, of course, be separate from the power, and if the lighting is but a small proportion of the load it may be taken from one pair of circuits only, thus simplifying the wiring and transformers.

The number of phases to use, whether two or three, is another point of difference; the two-phase dynamo and motor connections are somewhat simpler, while the weight of copper is less for the three-phase system. In factory and mill work, where the question of transformers is of no importance, the three-phase system has a slight advantage, but of so little importance as to be overbalanced by a possible question of delivery or machines in stock.

Questions as to the use of motors able to start under heavy load, or motors with or without brushes and with high or low power factors and similar technical points, may be left out of this discussion as they must be settled for each plant according to the conditions. In general, the brushless motor in a factory plant, while it avoids trouble at the motor, creates trouble in the rest of the system by disturbing the regulation, and gradual speed regulation with this type is impossible. With the brush and collector-ring type the system is subjected to no more serious disturbance than it would be with the direct-current motor, and speed regulation is easily obtained.

It is my opinion that at present prices the 125-volt direct-current two-wire system is the preferable one in most instances, and little or no trouble with the motors or dynamos is experienced at this voltage. Where the distance through which the power is to be transmitted is such as to make the cost of wires for carrying the current too great, the 240-volt direct-current three-wire system should be used. Where there are special features, such as those heretofore mentioned, or where the power is transmitted a distance too great for the 240-volt direct-current system, the three-phase alternating-current system, 60 to 70 cycles per minute, becomes necessary and gives thoroughly satisfactory results.

The greatest drawback to the alternating-current system today is its excessive cost which brings no equivalent advantage. In the course of a few years this difference will disappear, and the system will probably be used for all situations demanding a higher pressure than 125 volts.



THE GOLD MINES OF SIBERIA.

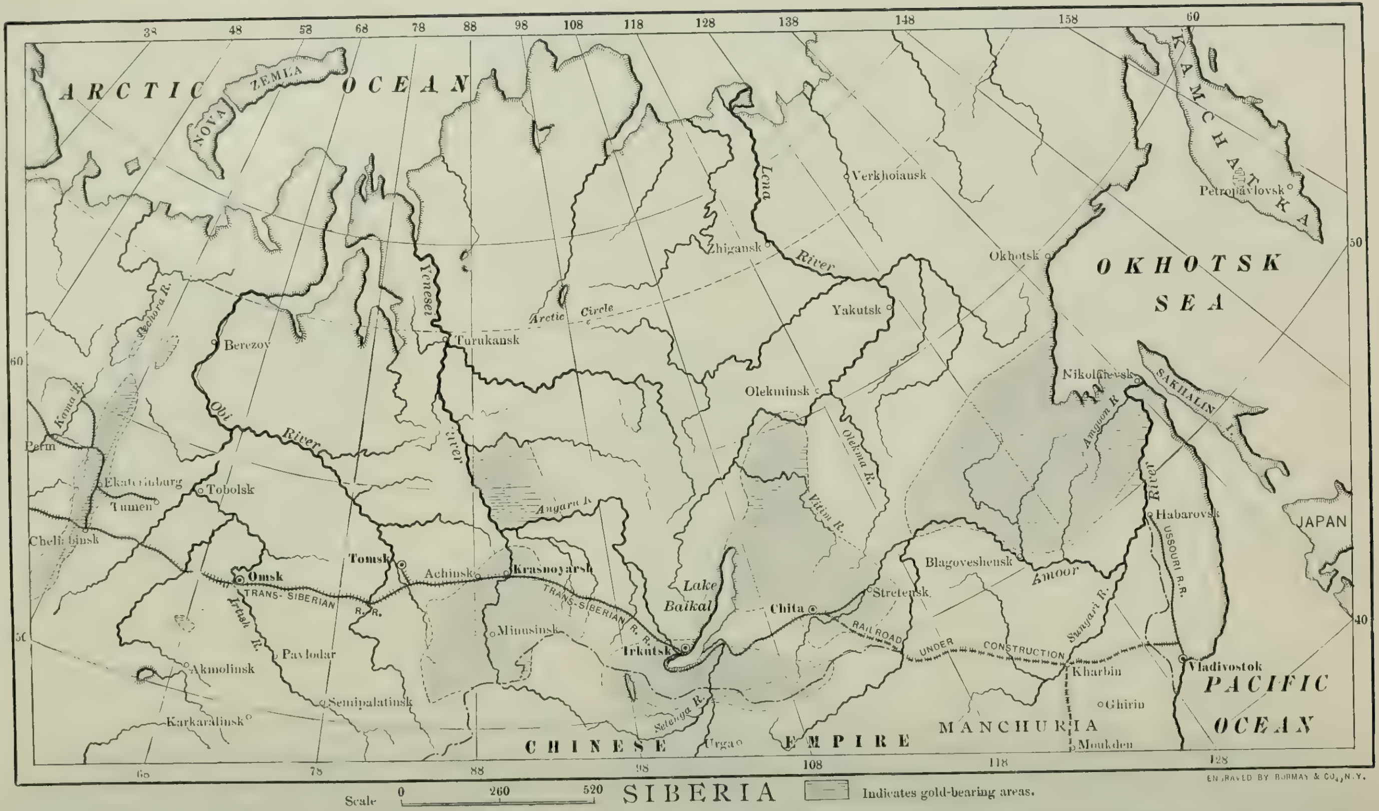
By Chester Wells Purington.

Within very recent years only has Russia begun to attract even a fraction of the interest her wonderful engineering and industrial possibilities deserve. How keen that newly awakened interest is, is proved by the remarkable attention given to Mr. Ford's series on "Engineering Opportunities in the Russian Empire," recently concluded in this Magazine. Mr. Purington takes up another side of the subject and gives a startling—almost sensational—view of the enormous gold wealth in Siberia waiting only for intelligent development. And this striking account is by a man thoroughly familiar with the field from four professional journeys. The illustrations accompanying the paper are from photographs by the author and by Lewis B. Brown.—The Editors.

Cossack Miners of the Urals.

TWENTY-FIVE millions of dollars in gold are annually produced and put into circulation by the miners who operate in the little-known regions of eastern Russia and Siberia. To many this fact will doubtless come as more or less of a surprise. For some reason, while Africa, Australia, South America, and Alaska have received a large share of the world's attention during the past fifty years, the vast territory of central and northern Asia has remained unnoticed and unexplored. Only very recently have the exciting events attendant upon the Chinese imbroglio caused the eyes of the civilized world to turn toward the vast domain of Russia, the coming world-power. It is not too much to say, although the statement may be received with considerable incredulity, that it is only within very recent time that Russia herself has paid much attention to her Asiatic possessions.

When in Moscow, outfitting for my first journey to Siberia, in 1898, I made diligent inquiry, among both Russian and foreign residents of the city, as to the necessary articles of baggage on such a journey. My inquiries elicited from most of my auditors only blank stares of astonishment at the thought of any man's taking such a journey as I contemplated. When I went to the office of the Wagons-Lits Company in Moscow to inquire the price of a journey across Siberia to Vladivostok, the French agent told me it was an impossible



MAP INDICATING THE POSITION AND EXTENT OF THE PRINCIPAL GOLD-BEARING DISTRICTS OF SIBERIA.

journey, and watched me narrowly until I left the office, evidently regarding me as some demented person, over whom it would be well to keep a surveillance. Had it not been for the courteous assistance of Mr. Enoch Emery, the American pioneer merchant of east Siberia, I should have fared but poorly in my efforts to obtain some preliminary information about that country. I was also greatly aided by Mr. Henry Hiller, an American who had traded in furs on the Amoor river in 1856, but who had not been through the country for many years.

THE TRANS-SIBERIAN VESTIBULED EXPRESS.

Were it true that Siberia is a country of small resources in a mineral way, or that these resources have in any sense become exhausted by present and former exploitation, I should not take the trouble to attempt bringing the country to the attention of the mining public. It is true that it is difficult to realize that in Asia, "the cradle of mankind," the oldest portion of the earth's surface known to historical research, there should exist beds of gold-bearing sand which have never given up an ounce of their valuable contents, and great reefs of gold-bearing quartz which have never yet been struck by a blow from the miner's pick or shattered by a single pound of giant powder. That such deposits do exist, not only in Siberia but in Mongolia and Manchuria, is a fact attested by all explorers and engineers who have visited the countries in question and have taken the trouble to investigate, even in the most superficial manner, the conditions which exist there.

In the first place, let us consider what is the gold-bearing area of Siberia. Divided into five districts, the auriferous areas in Siberia are as follows:

Ural district, (lying partly in Siberia, and partly in eastern Russia)	60,000	square miles
Yenesei district	280,000	" "
Trans-Baikal district (south)	20,000	" "
Trans-Baikal district (north)	160,000	" "
Amoor district	360,000	" "
Total gold-bearing area	880,000	square miles

As compared with these figures the gold-bearing areas of the United States are seen in the following table:

California	15,000	square miles
Rocky Mountain district, including Nevada and South Dakota	180,000	" "
Appalachian district	10,000	" "
Alaska districts	60,000	" "
Total gold-bearing area	265,000	square miles

In other words, the gold-bearing area of the United States is but little over five times the area of New York State, while that of Siberia is over eighteen times as great.

SIBERIAN TRANSPORT FACILITIES. A WAGON ROAD IN THE ALTAI.

It is doubtful if anyone today would question the statement that the United States is now the seat of operation of the most improved methods for mining and milling the ores of the precious metals. Especially have these methods been perfected to the highest attainable degree within the last five years, for the production of gold. The aim has been constantly to reduce operating expenses and to increase production. Yet in the year 1899, according to figures furnished by the director of the mint, the coining value of the gold produced within the limits of the territory belonging to the United States was but $71,053,400, or a little over $1 per head of the population. Siberia, during the same year, with a population of only 22,700,000, as nearly as can be estimated, produced, according to the returns published by the St. Petersburg mint, something under $25,000,000 in gold, or slightly over $1 per head of the population. By what methods the gold constituting this product is obtained in Siberia it is partly the purpose of this article to describe. It is sufficient at this point to note that they are, from the standpoints of capacity, saving of labor, time, and general practicability, diametrically opposed to the methods in use in the United States.

THE ALTAI MOUNTAINS. DOG CREEK IN THE FOREGROUND.

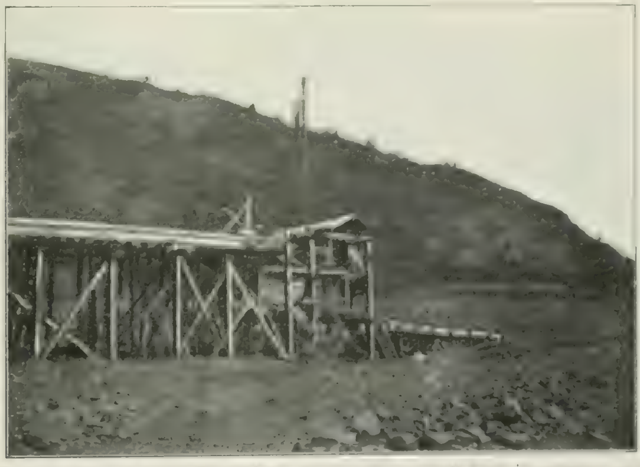
Placer gold, or gold found in stream deposits which overlie the gold-bearing quartz veins, his been and is today the source of the Siberian product. From the time when the Russians first commenced to exploit the Siberian deposits, during the reign of Catherine II., there has been but little change or improvement in the mining methods. The prevailing characteristic of the Slav, which may be described rather as conservative activity than as sloth, has caused him to adhere strenuously, one may almost say religiously, to the methods pursued by his ancestors. Placer gold was the first variety found by the early miners. In the history of all mining countries it has been the placer gold which first attracted attention. In California and Australia, however, to take two notable instances, mechanical methods of handling the gravels in which the gold occurs were an almost immediate consequent upon the finding of the deposits. To such a point of excellence was the hydraulic method of placer mining brought in California that bodies of gravel carrying but two cents to the cubic yard in gold were profitably handled, and their values extracted.

SIBERIAN TRANSPORT APPLIANCES. A TARANTASS ON THE STEPPE.

While the Californian and the Australian placer miners rapidly improved their methods of operating and increased their daily product, the Siberian made no changes. It is a most remarkable statement, but one vouched for by observers who have at different times traversed the country, that precisely the same types of gold-washing machines which were in use in Siberia before the discovery of gold in California are in use today in the gold mines of the Lena and Amoor rivers. Such innovations or improvements as have been made are so few in number and so insignificant in results as to be scarce worthy of mention. A short description of the typical washing-machine in use in Siberia at the present day may serve to give an idea of the very primitive methods employed.

SIBERIAN MINE LABOR. PEASANT WORKERS IN A PLACER.

A platform set on a staging of rough logs is erected to a height of 25 feet above the ground. The platform is 12 feet in width, and built sufficiently strong to support the weight of several small carts, loaded with gravel, with accompanying men and horses at the same time. An incline with gentle grade leads from the bottom of the gravel



TYPE OF SIBERIAN GOLD-WASHING MACHINE CALLED THE "AMERIKANKA."

bank which is being worked to the top of the platform. Water sufficient for washing the gravel is either led to the top of the structure from some point higher up the stream, or raised to the required level by means of a centrifugal pump, generally of small capacity. A hopper at the end of the platform opens directly into a horizontally revolving cylindrical screen, through the holes in which the gold and fine material is allowed to pass directly on to sluice tables, while the large stones fall from the lower end of the screen into a large bin, whence they are carted away. The actual saving of the gold on sluice tables is done much in the fashion of American placer-mining, although the operations are performed generally in a careless manner which allows most of the finely divided gold to escape. From the time when the gravel is dug from the bank with pick and shovel, hauled up the long incline in carts holding a quarter of a cubic yard, and dumped into the hopper, the operation involves the labor of men and horses entirely, with no mechanical assistance. The rocks and worthless gravel, called "tailings," are also gotten rid of entirely by hand labor in most cases, although at some mines various forms of elevators of small capacity are used.

SIBERIAN MINING METHODS. MOVING GRAVEL IN A GOLD MINE.

The result is that the Siberian placer miner expends a large share of his working cost for the hand labor involved in his operation. He never attempts to work gravels where the tenor is less than 33 cents to the cubic yard in gold. Besides this, his daily product is necessarily small. I know of no single machine of the kind described above whose capacity exceeds 500 cubic yards in twenty-four hours. One proprietor with whose operations I am familiar, in order to attain a product of $800,000 per annum in gold, uses 2,000 men and over 500 horses. The amount of gravel handled during the year is very nearly 1,200,000 cubic yards, and the cost of his operations amounts to three-quarters of the value of the gold produced. From thirty-five to forty machines of the type above described are in use on this property, and besides these there are countless small operations conducted by peasant "tributers." The ground worked in this expensive and laborious manner is in no way different from gravel mines in the United States where the handling and washing of the material is done entirely by means of steam excavators and conveyors.

The work done by the enormous body of men and animals quoted above would require only five American steam-shovels or land-dredges, with suitable machinery for washing the gravel, saving the gold, and disposing of the débris. The services of perhaps sixty men would be necessary, and engine and boiler capacity up to 600 horse power. The entire running and administration expenses would amount to something less than 15 cents per cubic yard of material handled, as against 50 cents by the Siberian method.

DUMPING GRAVEL INTO A SIBERIAN GOLD-WASHING MACHINE.

Did space permit, the citation of statistics from the Siberian operations might be indefinitely prolonged; but the above figures are sufficient to show by what slow and primitive means the annual twenty-five million dollar product of Siberia is obtained. I wish to emphasize especially the fact that this is almost entirely obtained from gold-bearing gravels, or superficial deposits, and that with very few exceptions no attempts have been made to work the quartz reefs lying underneath. In most localities these have not been even looked for, and when found by accident, they have rarely been tested to ascertain the amount of their auriferous contents. A few quartz mills are in operation in the Ural mountains, which are, with one exception, antiquated in construction and extremely inefficient in operation.

Deep mining, in the American sense of the term, is almost unknown in Siberia. So far as I know, there is not a shaft in any gold-quartz mine in the country which exceeds five hundred feet in depth, nor is there a tunnel a thousand feet long. When this sort of mining activity is compared with that which has recently existed on the South African Rand deposits, or with that of the great Comstock lode, where more than one hundred miles of shafts and tunnels were driven on the vein in a single year, the reasons for such startling contrast appear worthy of some investigation. That gold-bearing veins warranting extensive mining and milling operations exist in Siberia is beyond question. During the course of examinations of Siberian gold deposits extending over a period of fifteen months I have seen lodes in many parts of the country which if worked would pay large returns. An American company, which has established a small gold-mill in the Trans-Baikal district, to the south-west of Irkutsk, reports extremely

A FLUME IN SIBERIA, SHOWING TIMBER CONSTRUCTION.

A QUARTZ LEDGE AT THE HEAD OF DOG CREEK, ALTAI MOUNTAINS.

favorable results of its operations. Mr. E. D. Levat, a French mining engineer who has explored the country along the Onon river, near the Mongolian frontier, speaks highly of it as a quartz-mining country, at the same time condemning in strong terms the slovenly Siberian mills which have been installed there. In the Achinsk district of Siberia, lying to the west of the Yenesei river and about one hundred miles to the south of the Trans-Siberian railroad, I went with a party of four other Americans to visit the mines of a large Siberian proprietor. This gentleman, much more progressive than his neighbors, has recently installed a Krupp gold-mill of modern pattern at a quartz mine which he has lately discovered. On arriving at the mine after a long "tarantass" drive followed by a horseback journey over one of the foot-hills of the Altai mountains, we looked about with no small degree of curiosity. We followed our host up the gulch to the mine workings, and entering one of the prospect tunnels, proceeded to examine the ore.

The wall-rock of the vein appeared to be full of little crystals of iron sulphide, and on closer inspection particles of gold were visible. The finding of free gold in the rock, away from the quartz of the vein, was rather extraordinary, and it in some measure prepared us for the appearance of the quartz in the face of the drift. Here, by candle-light, on the face of quartz eight feet in width, appeared wire-like strings and masses of native gold, extending in lines more or less parallel to the walls from top to bottom of the drift, which was about six feet high. Such an unprecedented display warranted the opinion that here was the prize "specimen mine" of the world, or that Siberians were past masters in the art of "salting." More was to come, however. In no less than six openings on this vein, all following it from fifty to two hundred feet into the mountain-side, we were shown these marvellous exhibitions of free gold. Blasts of powder were put in wherever we directed. Specimens were taken from the fresh face, beaten up in mortars and panned. In every case gold was found, often at the rate of hundreds of dollars to the ton. Salting appeared out of the question, and a subsequent examination of the vein along a course of seven hundred feet showed the free gold already found in the tunnels. By an exhibition of his government record books kept by order of the mining department to accompany the consignments of gold turned in to the agents of the St. Petersburg mint, the owner proved to us that he had in four-months time taken over $50,000 from this vein, crushing only 18 tons of ore a day.

OLD TAILINGS BEDS IN THE ALTAI MOUNTAINS.
A promising opportunity for reworking by modern methods

That the deposit described above is not of an exceptional character in Siberia could be proven by the citation of numerous examples. It is sufficient to show, however, that where sensible and business-like mining operations have been undertaken they have met with success. By means of the railroad, central Siberia is now much easier of access than are portions of the United States, and the rates of transportation for both passengers and merchandise are extraordinarily low. Large cities, provided with first-class hotels and possessing all the luxuries of civilized life, are numerous. The climate is remarkably healthful and enjoyable, the winters, generally thought of as unbearable by persons ignorant of the country, being considered by all those who have experienced them the most enjoyable time of the year. Gold mines in the mountains of Colorado are operated the year round under conditions of climate far more inclement.

SIBERIAN MINING METHODS. WORKING A SHALLOW PLACER.

Mr. G. F. Becker, an American statistician and mining engineer of the most eminent authority, places the future production of the Witwatersrand gold mines of South Africa at $100,000,000 a year for the next thirty years—dependent, of course, upon the restoration of peaceful political conditions. I regard it as not an unsafe prediction to estimate the Siberian annual gold output at $200,000,000, for a period of at least thirty years, providing American machinery and gold-mining methods are installed throughout the territory now occupied by the Russian and Siberian operators.

THE PROPER DISTRIBUTION OF ESTABLISHMENT CHARGES.

By A. Hamilton Church.

III.—THE SCIENTIFIC MACHINE RATE AND THE SUPPLEMENTARY RATE.

Mr. Church's first article, which appeared in our July issue, dealt with the vital necessity of accurate cost keeping. His second paper analysed the chief accepted methods of apportioning general expense to individual jobs and pointed out their deficiencies. In this article he develops a comprehensive and accurate system. His next paper will take up the classification and dissection of shop charges.—The Editors.

IN the last article, an outline of a new basis of determining the incidence of shop establishment charges was given. Before passing to consideration of the preliminary measures necessary to its introduction, the effect and results of the method will be detailed. The apparent similarity of the system to the old device of the machine rate has been alluded to; the points of difference will now be brought into prominence. It will be remembered that the principle on which the proposed method was stated to be based, was that of dividing each shop up into its constituent "production centres" and giving full play to the natural differences between these as far as practicable, instead (as on the averaging plan) of throwing them into one common receptacle or lump sum of shop charges. It was also pointed out that this of itself would be subject to all the defects of the old machine-rate method, inasmuch as the problem of idle hours is still unsolved. There is also the problem of those actually general charges, which cannot by any reasonable allocation be connected with particular production centres.

Leaving these latter out of account for the moment, it will be seen that, admitting all machines or production centres to be running full time, it would be possible so to adjust the rents or machine rates payable for the use of these centres during one hour, that at the end of any period, say a month, the whole of the shop charges would find themselves attached to particular jobs, according to the time taken by each job.

TOTAL OF SHOP CHARGES FOR 1 MONTH—$200.

Machine.	Working Hours per Month.	Rate per Hour on New Plan.	Monthly Earnings on New Plan.
A	200	40 Cents	$80.00
B	200	30 Cents	60.00
C	200	20 Cents	40.00
D	200	10 Cents	20.00

Total hours worked by all four machines, 800. Hourly burden $= \frac{\$200}{800} = 25$ cents.

Total distributed by hourly-burden plan, 800 hrs. @ 25 cts. = $200.00.

Total distributed by machine rates on new plan, $80 + 60 + 40 + 20 = $200.00.

In the above schedule, there has been given the case of a certain shop, in which the monthly total of shop charges was $200. The time made by the constituent production centres, viz., machines A, B, C, and D, was 200 hours each, or 800 in all. Now on the hourly-burden plan this would give an average hourly rate of 25 cents for all jobs, on whichever machines they happened to have been done.

But it is assumed that the application of the new method and thereby the separation instead of lumping together of the incidence of charges has resulted in the rates of machine A being fixed at 40 cents, of B at 30 cents, of C at 20 cents, and of D at 10 cents. Again assuming the full number of hours to be worked, it is easy to see that we get considerable differences in the resulting incidence of shop charges on the two plans. The charge, for instance, on a job which occupied 5 hours of machine D and 1 hour of machine A would be:

On hourly-burden plan—6 hours at 25 cents = $1.50.

On new plan—5 hours on D at 10 cents = 50 cents; 1 hour on A at 40 cents = 40 cents; total, 50 + 40 = 90 cents.

We may now consider what would be the incidence under the percentage-of-wages method of distribution. Let it be assumed that the wages of operators on A and B machines are 20 cents per hour, and of operators on C and D machine 15 cents per hour. Reckoning, as before, 200 hours per month for each machine, we find:—

Total wages for one month, $140, and as shop charges are $200 this gives an average of 142 per cent. on wages-value for all work done, by whichever operator or whichever machine concerned. Hence we get the charges incident on the job we have been considering:—

5 hours of operator on D at 15 cents = 75 cents, on which charges at 142.9 per cent. = $1.07.

1 hour of operator on A at 20 = 20 cents, on which charges at 142.9 per cent. = 28 cents.

Total charges for job \$1.07 + \$0.28 = \$1.35.

We have now worked out this job on three methods, and find different results in each case, viz:—

On hourly-burden plan	\$1.50
On new plan	0.90
On percentage method	1.35

Which of these is most correct?

The nearness of results obtained by the hourly-burden and the percentage plan makes these two methods apparently support each other. But this in reality is due to the fact that we have assumed a very slight difference (only 5 cents) between the highest and lowest wages rate. This contributes to make the real basis of distribution as nearly uniform in this case as the hourly burden. By this is meant that the value of an hour having been made nearly uniform, it is much the same in effect whether we distribute on hours or value of hours. It will be recognised that in proportion as wages rates differ, so will the discrepancy between the distribution on the hour and on the hour-value increase. Between these two methods there is already a difference of 15 cents, which, as just shewn, might easily have been much greater if the difference in the assumed wages rates had been made larger. To begin with then, let us ask which of these two may be considered the more accurate. The discrepancy being clearly due to the introduction of the wages factor as a measure of incidence, we need only enquire whether this lowering of the charge under the percentage system is a nearer approach to truth than the other.

If we assume that the \$200 of shop charge is wholly made up of standing expenses, rent, interest, depreciation, and such-like, we must decide in favour of the nearer correctness of the hourly-burden plan in principle. It at least is based on an invariable basis, which, though not representing the real state of affairs, is constant in its error. But we can easily see that the other result has more of the element of chance in it. It will vary according to just what man has happened to be on the particular job. And if the worker did not receive any wages at all, the charges would be reduced to nil.

This objection still holds, though in the particular job cited the percentage plan has given us a figure nearer to that provided by the new plan than the hourly-burden figure, which we have notwithstanding argued to be the more correct in principle. This paradox is explained by the consideration that had by any chance the wages not been scaled proportionately to the machine rates, the discrepancy would be far greater between the new and the percentage, than between the new and the hourly plan. In the case of a low-waged operator working a highly rated machine, and *vice versa*, the discrepancies would plainly pass from positive to negative on the percentage plan, whilst on the other two plans they would not vary. The fault of the percentage plan is, then, that it fluctuates according to a factor which cannot be considered as really representing a true and corresponding variation in the incidence of shop charges. The fault of the hourly-burden plan is that it does not vary at all. As between these two evils, our preference must be for that one which produces the most constant error.

It has been assumed in the above argument that the new plan does produce a result not merely relatively more correct than either of the two others, but that it gives a normal result closely connected with actual conditions of work. Remembering that we are still discussing the case of a shop in which all machines are making full time, it is difficult to see how we are to avoid coming to this conclusion. It is evident that the standing charges, at any rate, comprising such items as interest and depreciation on particular machines, the proportion of rent, taxes insurance, heating, etc. (which may be considered as reduced to a certain uniform charge for each square yard of floor space, and thus debited according to the working space occupied by any machine) and all charges allied to these, can be as properly assigned to particular production centres as in the case of rents in large buildings which are let out in subdivided areas to tenants.

No sophistry is needed to assume that these charges are in the nature of such rents, for it might easily happen that in a certain building a number of separate little shops were established, each containing one machine, all making some particular part or working on some particular operation of the same class of goods, but each shop occupied, not by a wage earner, but by an independent mechanic, who rented his space, power, and machinery, and sold the finished product to the lessor. Now, in such case, what would be the shop charges of these mechanics? Clearly they would comprise as their chief if not their only item, just the rent paid. And this rent would be made up of: (1) Interest. (2) Depreciation. (3) Insurance. (4) Profit on the capital involved in the building, machine, and power-transmitting and generating plant. There would also most probably be a separate charge for power according to the quantity consumed.

Exclude the item of profit, which is not included in the case of a shop charge, and we find that we have approached most closely to the new plan of reducing any shop into its constituent production centres. No one would pretend that there was any insuperable difficulty involved in fixing a just rent for little shops let out on this plan. Nor can there be any more difficulty in fixing the proper charges for each production centre in a large shop. The little shops are, in fact, a large shop when we take away the partitions which divide them. The presence of these partitions certainly seems to make the problem more definite and concrete, but this is a mere illusion. There is a new point of view involved, which, once grasped, enables us to see separately things which otherwise have a look of conglomeration.

This illustration of the little independent shops is also useful in helping to discuss the question of idle hours. In each of these little shops, whether idle or busy, the rent is going on all the time. Only the charge for power might conceivably be stopped whilst the shop was shut. Now if the mechanic in one of these shops is only working half his time, it is pretty clear that he must double his rate of distribution on such work as he does, if he is to distribute his month's rent over his month's work. But instead of doubling his rate, he might continue to charge at the normal rate, and then at the month end find how much he was yet in arrear, and distribute this undistributed amount only as a *supplementary rate*. In this way he would benefit in two ways. First, his normal rate being constant, he can compare costs of jobs worked on at different periods, and secondly the amount of the supplementary rate, (its ratio to the normal rate,) will serve as a very accurate barometer of the conditions under which he has been working at any period. If the normal rate has been so fixed, for instance, that when fully employed the supplementary rate was *nil* per cent. of the normal, then if he observes it steadily rising 5 per cent., 10 per cent., 15 per cent., etc., he may be fairly sure that things are not going well with him. Of course, in the case of a little shop, this would be perfectly clear to him without the aid of the rates to tell him so; but if we, now, throw down all the partitions and make the hundred separate little shops into one large general shop, this information may be very important indeed to those in authority.

The meaning of the term supplementary rate will now be understood. It is this which is the invaluable complement to the machine rate and which makes the great distinction between the new method and the old machine-rate method. *The supplementary rate is the undistributed balance of shop charges due to idleness of productive centres.*

In the illustration just given of the little shops, it will be seen that the undistributed balance due to slackness of one machine is thrown onto whatever work is done at all on that machine at some time or other. This is, of course, necessary in the case of independent little shops, but when the partitions are down, and we consider the case of a *bon fide* large shop with a number of production centres, this is no longer always possible, or even desirable from some points of view.

The idleness of a machine may or may not be considered as the fault of that machine. If, for instance, a machine was found to be idle nineteen-twentieths of its time, this might be due to one of two causes. Either the process was rare but essential, or the machine itself was largely superfluous. In the first case it would be eminently fair that the charge should be made very high when it was put in use, since the shop charges due to its presence and up-keep are indubitably incurred for the sake of this occasional use. In the second case it might be rather as a matter of accommodation that the machine was retained at all, in which case the shop as a whole should bear the burden, and not the unlucky piece of work that should happen to be put on such machine at any time.

Here we have one of those matters of principle which are incapable of a general solution. The procedure proper would vary according to actual circumstances. Nevertheless, the general practice will probably be that idle machines shall get rid of the burden undistributed during their idle periods, not by charging it specially in their working periods, but by transferring it to the general shop-charges account.

If we adopt this view of the usual destination of idle hour's burden, then we introduce at once a striking difference between the case of the little independent shops and the same machines considered as production centres of one large shop. In the former, idle time accumulates against its own machine; in the latter, all undistributed charges fall, not into the supplementary rate of particular machines, but into a general supplementary rate for the whole shop. It is also into this supplementary rate that the really general expenses of the shop fall.

The full outline of the new plan may now be seen. First, we consider each machine as an independent production centre, allocating to such centres all the expenses and charges which can, on reasonable analysis, be considered as chargeable as a composite rent or machine rate for all the factors of production therein concerned. Second, we charge to a monthly shop-charges account all charges whatever incurred by that shop, including all the items specifically represented in fractional detail by the machine rates, and also including, of course, such general items as cannot be represented in the machine rates, of which the most obvious item is the supervision of a head, or foreman.

Then, as each machine is occupied on jobs, the latter are debited with so much per hour as machine rate, and at the end of the month the total amount so earned by the machines, *is deducted from the total shop expenses,* leaving a balance which is distributed over the same jobs as a *supplementary rate.* The ratio of the supplementary rate to the amount distributed by the machine rates forms a varying barometer, whose fluctuation is an index to the current efficiency of the shop.

It will, of course, be obvious, from what has already been said, that when the machines are all running full time the supplementary rate will consist of the general charges alone, such as the foreman's wages, which have not any individual connection with particular machines. This will be the condition of maximum efficiency in the shop. In proportion as all machines are not kept full of work all the time, this ratio of the supplementary rate to the amount distributed by the machine rates will begin to rise. The same effect will occur if any general kind of expenditure is increased.

While we have now seen the principle of the supplementary rate in detail, there yet remains the question on what basis the additional distribution shall take place. It may, for instance, be made into an ordinary hourly burden, or, which is simpler, may be reduced to a percentage of increase on the amount already distributed by the machine rate. In the case of the shop whose charges amount to $200, cited above, we may suppose:—

Machine A worked 120 hours @ 40 cents = $48.00 for month.
Machine B worked 134 hours @ 30 cents = 40.20 for month.
Machine C worked 169 hours @ 20 cents = 33.80 for month.
Machine D worked 200 hours @ 10 cents = 20.00 for month.
Total 623 hours. Total burden distributed, $142.

Now deducting the total burden distributed through these machine rates, viz., $142, from the full month's total of shop charges, viz., $200, this leaves $58 as a residual or undistributed amount. This forms the amount to be made the subject of the supplementary rate, but this itself may take two forms. It may be treated as an hourly burden, thus:—$58 spread over 623 hours worked = $9^1/_3$ cents per hour, which amount would have to be added to the amount already allocated by means of the machine rate; or, it might be that the residual amount is reduced to a percentage of the amount already distributed, thus:—total burden distributed by machine rates, $142, residual amount, $58; supplementary rate = per cent. of increase on machine rate amount, = 40.9 per cent. On this latter plan the calculation of the correct incidence of shop charges is reduced to a very simple matter. First we get a certain amount charged against the job by the medium of the machine rate. This represents strictly the normal charge for that machine when under full work. Then at the month end we find the actual ratio of undistributed to distributed charges, and increase the debit against individual jobs accordingly. Thus:—

5 hours of machine B at 30 cents = $1.50
Supplementary rate at 40.9 per cent. = $0.61

Total charges.................. = $2.11

This represents: (1) A proportion of the really general charges of the shop, and (2) An averaged distribution of the idle hours of any or all the machines in the shop.

As by the new machine-rate plan we have only subtracted from the total charges just those charges which *can* be connected with different production centres, it follows that, as regards the remainder, we are again face-to-face with the problem of finding a suitable basis on which to make the distribution of incidence.

The discussion of which is the better and more just way of distributing this residual amount, or supplementary rate, is worthy of some attention. Theoretically, as regards the idle hours we are averaging these over the work actually done, and this is on the basis of their being considered as the fault of the shop as a whole, and not of any particular machine; but this may be as well attained by distributing the supplementary amount directly as an hourly burden, or a *pro rata* increase of amounts already charged through the machine rates.

The general, or, as we might more conveniently term them, the floating shop charges, plus the unallocated charges due to idle machines, are obviously not connected in any definite way with the work. They must be averaged on one basis or another, and this basis should be as constant, that is, subject to as few variations, as possible. This definition is better fulfilled by the hour than the hour-value. It is to be preferred, therefore, that the supplementary rate should be an hourly-burden rate. This, though not quite as simple in routine as the percentage form of supplementary rate just described, is the more accurate, because the incidence of the unallocated charges cannot be considered as varying with the value of different machines, but rather as pressing equally on all work done in the shop hour by hour, irrespective of whatever machine it may be done on. Nevertheless, the percentage supplementary rate is not without its arguments, since it means virtually a *pro rata* increase of machine rates in slack times, and this is very much like what might be conceived to happen in the case of the separate little shops which have been used as an illustration, supposing that from one cause or another it became necessary for the landlord or owner to get the same return out of a smaller number of little shops. He would raise the rents. But this is exactly equivalent to a distribution of the supplementary rate as a percentage on the amounts already distributed by machine rates.

This is in any case quite a different matter from a percentage distribution of shop charges on wages, and is not vitiated by the arguments already directed against that method. At this stage the matter may be left an open one, with preference in favour of the hourly-burden method of distributing the supplementary rate.

A summary of the complete scheme of machine rates and supplementary rates is now possible.

The principle followed is to connect expenditure with production centres, (which for the most part mean machines) wherever this is possible and as far as it is possible. These charges are debited to jobs by machine rents or rates so carefully arranged as to include all of them. All these items of expenditure, and others which we term floating or general items (which do not enter into the composition of the machine rates at all) are collected into a monthly shop-charges account. This account is relieved by the total of charges which have been debited to jobs during the month, by means of machine rates, leaving in the account a residual sum, which has yet to be got rid of and allocated to jobs. The supplementary rate affects this, either by reducing the residual amount to an hourly burden, distributed over the jobs in the usual way, or, more simply but somewhat less accurately, by finding the proportion or ratio of the residual sum to the amount already distributed by machine rates, and then increasing the amounts already allocated to each job by so much per cent.

It will be obvious that by this means *all* the charges will be distributed, leaving nothing in the charges account, and that if all the machines have made full time in the month, the supplementary rate will only represent the floating shop charges. In proportion as machines are idle the supplementary rate will rise, because only working hours are credited to the shop account as per the total of the machine rates found at the end of the month.

Thus we secure that each job gets its own expenses only attached to it, plus an average of floating charge and of what surplus may be due to slack times or inefficiency in the shop.

THE MARINE WATER-TUBE BOILER.

By John Platt.

THE recent trials of two British cruisers, the one fitted with Scotch and the other with water-tube boilers of the Belleville type, has again brought up the much discussed question as to which is the better for fast ships of the battle-ship and cruiser classes. The activity of the argument has been much augmented by the stand taken by many technical papers and the daily press, in assuming from the results obtained and from the report of the British water-tube boiler commission that the Belleville boiler was wholly bad, and that vessels fitted with it were necessarily of no account.

It is not my intention to discuss the merits and demerits of Scotch and water-tube boilers in this article. The fact will be taken for granted that for large fast naval vessels, a large proportion of the boiler installation must of necessity be of the water-tube type. Rear Admiral George W. Melville, the well known and brilliant chief of the bureau of steam engineering of the United States Navy, has given detailed reasons why he has now been forced to use water-tube boilers. As is well known, his bureau has specified water-tube boilers in all the ships authorised by the last two congresses.

The subject will be discussed from the stand-point of one who has had experience with the express type of water-tube boilers, the question being raised as to whether full advantage has been taken of the very excellent results obtained from their use in torpedo boats and destroyers, particularly considering the fact that in such vessels boilers are forced to a much greater extent than in any others.

It was only as far back as 1887 that the first torpedo boat was fitted with water-tube boilers. Since that date many different forms of these boilers, all built of high-class materials and with modern boiler-making details, have been used in big ships. At the present time, even with this experience, we seem to be very little nearer the knowledge as to what is the best form of water-tube boiler to use where from 15,000 to 30,000 horse power is required, as is the case in large battle-ships and cruisers and in ocean liners. In considering the question it seems to have been very generally taken for granted that the proper form of boiler for this purpose must have large straight tubes—that is, tubes of from 3 inches to 4 inches in diameter—this notwithstanding the fact that there were so many practical reasons available to show why developments along other lines would tend to give excellent results.

The water-tube boiler was never very successfully used on board ship until torpedo-boat practice made the employment of the type absolutely necessary to enable the builders to obtain the speeds found possible in a boat of a given displacement. The locomotive type of boiler gave good service and was used with air pressures from 8 inches to 10 inches, this high pressure latterly being necessary to give the large amount of power required. Such extreme forcing with the rigid form of construction led to leaky boilers and many disasters. Again, the weight of the boiler was great for the horse power given out. The problem that the boiler builders had before them was to design a boiler that could be forced, that would be economical, and of the lightest weight possible. This, as is well-known, was successfully done and the results obtained from the use of these boilers led to a great increase of speed in the boats.

The boilers worked out for this purpose were of two general types —the one with small straight tubes, and the other with small bent tubes, the tubes in each case being of outside diameter from 1 inch to 1⅜ inch. They are generally spoken of as "express" boilers. Innumerable forms of these two general types have been designed and built during the last ten or twelve years. Many of these have been of defective general design, and many with such bad boiler-making details that at the present time the whole class suffers from the unsatisfactory results obtained from the large number of poor ones.

It will be instructive to see to what extent the express boiler has been used in torpedo-boat and destroyer work, and the size and number of the units employed, so that we can the better determine its suitability for use in the larger high-power ships. The first torpedo boats in which they were used required only from 1,000 to 1,500 horse power and two or three comparatively small boilers were sufficient. The latest United States destroyers require 8,000 to 8,500 horse power, and as only four boilers can well be used for this purpose, the size of the units must of necessity be large. Some of these particular boats have already run their trial trips, obtaining the amount of horse power required. On their full-speed trials, from 25 to 28 horse power per square foot of grate was developed. In a large number of similar boats in the British Navy the horse power per square foot of grate runs up to 30 and even 31. Notwithstanding this very extreme forcing, the horse power was obtained in all cases under 2.5 pounds of coal per horse power per hour, the consumption in some cases being as low as 2.2 pounds. The objections that might be looked for from such extreme forcing are low economy, wet steam, priming, and difficulty in keeping clean fires. The British Admiralty torpedo-boat destroyer tests show clearly that well designed boilers of the small bent-tube type are economical, and steam would not allow of this economy being obtained. With the very quick-running engines used on destroyers, priming would inevitably lead to serious disaster. Such disasters are few. On destroyers, the good quality of the coal used and high air pressure necessary to burn from 60 to 70 pounds of coal per square foot of grate per hour, have together done much to enable the fires to be kept clean, so much so that there has been no difficulty at all, where good coal has been employed, in obtaining easily the full horse power at the end of the three-hours official trial.

The first large ship in which the modern boiler was fitted was H. M. gunboat Speedy, built in 1892. The Speedy has a battery of eight boilers which developed on trial 4,700 horse power. As each boiler had only 23.5 square feet of grate and 1,840 square feet of heating surface, it will be seen that the units were small. Small boilers have been found in practice to be more difficult to handle than large ones; but even with a battery of eight such small boilers, in ordinary service, the navy stokers have easily been able to get 5,000 horse power out of the boilers. The Speedy's boilers had $1\frac{1}{8}$-inch and $1\frac{1}{4}$-inch tubes respectively of 12 and 14 B. W. G., and the boilers were made no heavier than torpedo-boat practice called for. The tubes in these boilers lasted for over seven years without renewals and the boilers gave no trouble at all. A similar installation was fitted a little later in the ironclad Aegir of the Imperial German Navy, and the boilers were later fitted to the Hagen and Beowulf, sister ships to the Aegir. These have all given excellent results, and the express type of boiler is being more largely used in the German navy than any other form of water-tube boiler. In the later ships the Germans have used part single-ended cylindrical and part express water-tube boilers. The advantages of this system will be referred to later on. Twelve battle-ships and cruisers of from 11,000 to 13,000 tons displacement and 13,000 to 16,000 horse power and all the second-class cruisers are fitted throughout with small bent-tube water-tube boilers. Both the Danish and Dutch navies have a number of vessels fitted with express boilers.

In spite of the fact that in 1894, when Sir A. J. Durston determined to use water-tube boilers, he had the experience of the Speedy and the boilers in the torpedo boats and destroyers to look to, both he and the water-tube boiler committee did not seem to be able to get the idea out of their minds that for big ships only boilers with large straight tubes were suitable. Thinking as they did at that time, the Belleville boiler was the natural one to take up. The express type was used only in third-class cruisers, the greatest amount of horse power in any such boat being 7,000 horse power. These boats were not suited to the proper development of this boiler, as from their general form a comparatively large number of small units were necessary.

In the United States Navy the bureau of steam engineering have to a great extent taken the same stand, and now specify water-tube boilers with straight tubes 2 inches or more in diameter. Before this ruling was made, two battle-ships, the Ohio and the Missouri, each having 16,000 horse power, were approved; also a monitor with 4,000 horse power. These two battle-ships will enable a comparison to be made with the large-tube boiler, as a sister ship, the Maine, is being fitted with Niclausse boilers.

The Ohio, building at the Union Iron Works, San Francisco, has a battery of twelve Thornycroft boilers. A little more floor space is taken up by the express boiler, but the boiler-room weights of the Ohio are much less than those of the Maine. The use of only twelve boilers instead of twenty-four means that there are only half the number of water levels to be looked after, and that only twelve sets of boiler fittings, stop valves, etc., have to be supplied and taken care of. As only about 16 horse power per square foot of grate area has to be developed in the express boilers, the stack temperature will be from 400° to 500° F., rendering the use of an economiser unnecessary. This advantage is an important one, possessed in the greatest degree by the boiler with small bent tubes in which the gases are made to take the best possible course by means of a wall of tubes. In the large straight-tube boilers artificial means of baffling are often made use of, and even with these, in many cases, under the same conditions of steaming, the flue temperatures are several hundred degrees higher. This has led to the use of economisers, which should be considered as part of the boiler when taking account of heating surface.

To recapitulate, the experience gained from the study and use of the express boilers leads one to claim the following advantages over the boilers of the large straight-tube type:

Saving in weight; smaller number of units possible, and hence fewer steam fittings to take care of; low stack temperature, and quicker steaming. In the types having small bent tubes—owing to the flexibility of the tubes—freedom from straining at the tube ends; positive and vigorous circulation, and hence no possibility of steam pocketing.

These advantages have been fully made use of only by the Germans. They are now working on the principle that for fast cruisers and battle-ships the ideal system is made up of an installation consisting of two-thirds water-tube boilers of the small bent-tube type and one-third cylindrical or Scotch boilers. It is claimed by them that the lighter weight, ability to stand extreme forcing should it be necessary, and quick-steaming power of the express boilers of the class above named, make it for tactical reasons the best possible for this class of ship. The cylindrical boiler, with more reserve of water, and better adaptability for use with impure water, is used for slow cruising and in port for evaporator and electric-light work. The following extract from a statement made by a leading German naval engineer connected with one of their large shipyards, will bear out the above statements:—

"You make mention that in England a great current of opinion is going in favour of straight tubes, but in our marine one is getting farther and farther therefrom and drawing towards the bent small tubes, owing to the advantages of the same—especially life, good circulation, and safety in working, which abundantly outweighs the disadvantages of the inner cleaning of the tubes."

That the above statement is correct can be readily seen from the fact that of the battleships and cruisers of the German Navy, 20 per cent. of the boilers are cylindrical, 25.5 per cent. large-tube water-tube boilers, and 54.5 per cent. small bent-tube water-tube boilers.

In speaking of the recent large ships of his navy he says:—

"In Nos. 1 and 2, two-thirds of the boiler space is fitted with cylindrical boilers and one-third water-tube boilers; in Nos. 3 to 10, one-half cylindrical and one-half water-tube; in Nos. 11 and 12, one-third cylindrical and two-thirds water-tube boilers. With the results of the first ships one is extremely satisfied, and it is hereby specially to be noted that the cylindrical boilers, since the addition of the water-tube boilers, have had definitely greater care taken of them. In the cylindrical boiler, at the most, 110 to 120 kilogrammes of coal per square metre of grate surface per hour was burnt, whereas in the water-tube boiler proportionately higher results have been obtained, viz: 190 to 210 kilogrammes of coal per square metre of grate per hour, and, in fact, with very good economy in the latter boiler."

"The small-tube water-tube boiler is thus having preference over every other type, especially with regard to its adaptibility in war times. The report is unanimous from all sides of the front, that is from officers and personnel who have had to do with the boiler, that these boilers are best suited to the purpose. With reference to harbour purposes, and also the use on long sea voyages at moderate speed, a part of the boiler installation will still consist of the old large water-room (cylindrical) boilers, which can very easily work with not quite clean feed water."

Speaking of the large-tube water-tube boilers in use in the Imperial German Navy he says:—

"These boilers require, in order to have the necessary working safety, a proportionately high weight in order to receive the safety of working of the small-tube boilers. Dirty water and scale have a very injurious influence on tubes placed near the fire and also on the higher rows of tubes. They easily warp through deposit of first a little and then more and more scale, and the circulation on the inner side of the tube will be hereby influenced, and through the weakening of the tube as soon as an over-heating takes place it is greatly weakened so that even with the best seamless material at first a tear and then an explosion takes place, which endangers the life of the crew in charge. Similar results can take place in the small-tube water-tube boiler even by the use of bad or unfiltered water."

"A further objection to the large-tube boilers is on account of the careful inspection that is required, especially of the inner row of tubes. In case of war one would not be able to carry out a complete inspection, as far too much time would be lost by the taking adrift and refitting of these tubes with the thousands of doors. Against this, in the case of the small-tube boiler, the inspection and cleaning take no more time than in the case of the old cylindrical boiler; in both cases the inside is immediately accessible after taking away the manhole doors. All tube connections can be easily inspected, as the upper and lower barrels are roomy enough for both inspection and cleaning."

The foregoing has been written in the hope that it will cause more attention to be paid to the possibilities of the express type of boiler for use in big ships, and particularly when used in combination with cylindrical boilers.

EDITORIAL COMMENT

Possibly the greatest engineering interest of the recent weeks has been the strike in the American steel industry—a strike which as we go to press is no longer great. Its failure already discounted in the street, its progress relegated to subordinate position in the press dispatches, the pyrotechnic display promised by Mr. Shaffer has sizzled in the fuse and sputtered and smouldered, instead of bursting into a majesty of flame as predicted.

The interest was intense because of the fundamental importance of the steel industry, stagnation there being more universally paralysing even than general stoppage in the engineering trades—which, indeed, would inevitably follow; but it was yet more intense because of the international scope of the question. A cartoonist represented the United States Steel Corporation and the Amalgamated Association as two dogs, fighting for the bone of "Profits," while John Bull, leaning over the fence with gleeful interest, cries "Seize him!" It is a very short-sighted view which does not comprehend that trade-union success in this instance would have been scarcely less disastrous to Britain than to America. Economically, the countries are now so closely bound together that each furnishes precedents for the other. The great engineers' strike of 1897-1898 predetermined the result of the American machinists' strike of 1900-1901. If trade-unionism had imposed its conditions on the American steel trade in this struggle, the bonds would soon have been fastened on Britain also.

* * *

The whole contention has been like to that over which Britain struggled four years ago—the reasonable delimitation of the rights and powers of the union. The steel managers were entirely willing to agree with the unions' officers touching the unionised mills; they proposed to continue conditions exactly as they had been, curtailing in no jot or tittle the power or influence of the Amalgamated Association. The other mills were to remain open, with no discrimination by either side against either organised or unorganised labour. The union demanded that the Steel Corporation agree with them as to *all* its mills, non-union as well as union, effectually throwing under union regulations the enormous body of workmen who for reasons presumably acceptable to themselves had preferred to remain outside of any organisation. The issue was joined, of course, only over the tin-plate, sheet, and hoop mills, but whatever was done there was an inevitable precedent for the entire range of the industry. There was no question of wages, hours, or conditions of working—it was purely an issue or recognising and submitting to trades-union domination. The Steel Corporation met it promptly and positively and the end is history. If the Amalgamated Association has suffered, it is through the folly of its own leaders in taking an untenable position and then forcing a fight.

* * *

It is deplorable that the men must have reason and experience beaten into them, but the world has gained most of its knowledge that way,—and cheap enough at the price, if only the knowledge is held and used. The trouble is not that they do not think, but that they think with a twist, and the twist can only be corrected by surgery—costly and painful. Unionism is to them an absolute, deserving of anything it may demand, justifying any act of its devotee, nullifying any obligation elsewhere. Mr. Shaffer in seeking to make the strike general by calling out the satisfied workers in other departments of steel manufacture says:

> "You will be told that you have signed contracts, but you never agreed to surrender those contracts to the United States Steel Corporation. Its officers think you were sold to them just as the mills, with contracts and all. Remember, before you agreed to any contract you took an obligation to the Amalgamated Association. It now calls you to help in this hour of need."

In this instance, however, the men in very large proportion showed greater economic wisdom and a higher sense of business morality than their leaders, and regarded their working contracts rather than the autocratic demands of the union officers. If any justification were needed for the Steel Corporation's attitude in declining to extend voluntarily the power of the Amalgamated Association, it is this utter irresponsibility displayed by the Association's officers. That, and not any opposition by the employers, will do more to discredit the cause of unionism than long and painstaking effort can atone for.

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Touching the matter of responsibility of the trades-union, the decision recently rendered by the House of Lords in the Taff Vale Railway case has the utmost significance, especially as by established usage English precedent is weighty in American law. Briefly, the railway sued the Amalgamated Society of Railway Servants for "besetting" (American, picketing), employees willing to work during a strike. The Society offered the defense that a trade union could not be sued. Mr. Justice Farwell, sitting in the case, decided for the railway. The Court of Appeals reversed, but the House of Lords reaffirmed the original decision. The Lord Chancellor stated it thus: "If the Legislature has created a thing which can own property, which can employ servants, which can inflict injury, it must be taken to have impliedly given power to make it sueable in a court of law for injuries done by its authority and procurement." The railway company is granted a perpetual injunction against the besetting annoyance and given permission to proceed against the society for monetary damages for its injuries sustained.

It has been held good law that "where there is a wrong there must be a remedy." Now that it is clearly ruled that the remedy in the case of union tyranny is against the union itself, a long advance is made in establishing the means of discipline by which organised labour may be educated from the wrong-headed things it so often attempts, to the great good it may do. Leaders will be much less ready to suggest, or followers to commit, acts injurious to the property or the rights of others when they are certain they must assume the accountabilities of a corporation as well as enjoy its privileges. And the ultimate result will be highly advantageous to the cause of organisation among workingmen. The rod may belong only to very early periods of education, but that seems to be the period through which trade-unionism is now passing.

* * *

One of the most disappointing things frequently observed in connection with great exhibitions is the unsatisfactory management of the exhibits themselves by their exhibitors. It is surprising that this feature has been given so little attention by manufacturers and others who expend large sums in providing and installing exhibits, and who then place them in the hands of individuals who either neglect them, or worse, actually repel the interested attention of visitors. It is the exception rather than the rule for visitors to be welcomed to examine the various devices and machines shown by many first-class manufacturers, and indeed the general rule seems to be to regard with suspicion any one who desires to look at things.

If the machines or exhibits are not to be seen and understood by all there can be no good reason for occupying space with them at all, while if the makers really desire to get the full benefit of the space and the cost, they should at least understand that polite, courteous, energetic, and really competent attendants, supplemented with intelligible printed matter, form the final element in the relative success or failure of the attempt.

REVIEW OF THE BRITISH PRESS

Comparative Boiler Trials in the Navy.

It is curious to observe the peculiar inverse process which has been adopted by the Admiralty in treating with the fundamental question of boilers for the navy. First the decision is made that cylindrical, or "tank" boilers are no longer the best type for naval use; followed by the adoption of the Belleville water-tube boiler for several of the finest battle ships under construction at that time, together with the payment of large sums for the use of patent rights. Then, after repeated mishaps with the Belleville boiler, and a general expression of distrust in the policy of putting this boiler in additional vessels, comes the appointment of a commission to report on the relative availability of the Scotch or the Belleville type, together with the desirability of trying some other forms of water-tube boilers. Then, upon the report of the commission deciding positively that the Scotch boiler was no longer suitable, and that water-tube boilers should be used, together with the sweeping condemnation of the Belleville boiler, comes the comparative trials between the boilers of the Minerva and the Hyacinth, for the purpose of finding out which of the two condemned types is really the better. So we have the cruise to Gibraltar and back, in order to enable the commission to find out something about the two types which they have already decided to be altogether unfit. It is a situation altogether worthy of Lewis Carroll, and should have taken place in that land beyond the looking glass, where everything was reversed as a matter of course.

But the Minerva and the Hyacinth have had their run, and although the policy was all decided in advance, and the Scotch boiler and the Belleville had already been condemned, we have some interesting information about the result, which might possibly have modified the report had the procedure been in a different order.

From accounts in *Engineering* and in *The Engineer* we extract data and results of the runs, which, although not official, are doubtless altogether accurate and reliable.

The two vessels are so nearly alike as to make the results fairly comparable, although there are slight differences which may be noted. The Minerva is 360 ft. by 54 ft. by 22¾ ft., and 5,600 tons displacement. The Hyacinth is 10 feet shorter, the same beam, and a little greater depth, and of the same displacement. The Minerva has eight cylindrical boilers and two funnels, the Hyacinth having eighteen Belleville boilers and three funnels, each vessel having two screws.

So far as evaporation is concerned, the Belleville boilers made a good showing. Three trials were made; at 2,000 h. p., at 5,000 h. p., and at 8,000 h. p., with the average result of 9.66 pounds of water per pound of coal for the Belleville and 8.73 pounds for the Scotch boilers.

The run to Gibraltar and back was rather a trial of the two vessels than of the boilers, and so far as speed goes, gives no information of value. So far as the general behaviour of the boilers at sea is concerned, however, it does give some information, although on a smaller scale than has already been obtained elsewhere. On the Minerva affairs were altogether uneventful, and barring the breaking of an eccentric strap, which was promptly replaced, there is nothing requiring comment. In other words, the Scotch boilers behaved just as they are behaving in countless merchant vessels making voyages in all parts of the world, steaming at their normal capacity, or with moderately assisted draught.

On the Hyacinth the customary state of affairs on vessels of the Royal Navy equipped with Belleville boilers, existed. At first all went well. Then began a mysterious loss of water, which it appeared impossible to trace. The evaporators were called upon to their capacity of six to seven tons per hour, and yet no excess of water was found in the bilges or hot-well. Ultimately it was thought that a multitude of small leaks must have existed, and that the leakage evaporated and went up the chimneys. For this reason a careful overhauling of the boilers was made at Gibraltar, and the hydraulic test applied, although there is no reason why this should have been necessary after such a short run.

The most surprising thing about the trials was the promptness with which both vessels got up steam for the return start. One of the chief advantages of the water-tube boiler is the quickness in getting up steam, but in this case the Minerva was at full speed within two hours from the time of the signal for start, being but little behind the Hyacinth. The Scotch boilers behaved on the return run as steadily as when outward bound, while the Belleville varied the monotony by bursting a tube and scalding a fireman so severely that he had to be sent to the hospital upon arrival.

It will be seen that the trials lead to absolutely nothing new. The weak point of the Belleville boiler, i. e., its behaviour when forced, was not tried at all, and the run was far too short to form any serious test of endurance. The efficiency test, being largely mixed up with the performance of the engines, the vessels being differently engined, gives little useful information, since the superior evaporative power of one type of boiler was offset by the greater amount of water it had to evaporate for a given power, and the coal consumption was about 2 pounds per horse power in both cases.

If anything, the cylindrical boiler stands rather the better for the test, while the Belleville stands just where it did before. The one is steady, reliable, fairly economical, and a good steamer. The other is a good steamer, but is liable to slight leaks, annoying break-downs, and uncertain performances. Just what advantage it is to the Admiralty to find out these things all over again, remains to be seen.

In the meantime, there appears to be a way out of the present muddle which has been suggested before, but which has thus far not been acted upon, at least not in the Royal Navy. This is to use both Scotch and water-tube boilers in conjunction, employing the cylindrical boilers for regular cruising, supply of auxiliaries, and similar routine service. The water-tube boilers, which in this case should be of the small-tube express type, should be always ready for emergency service, capable of getting up steam at the shortest possible notice and able to produce a spurt of speed so vital to success in engagement. This arrangement was made several years ago in the United States coast-defence vessel Monterey, in which the Ward water-tube boiler was installed in connection with cylindrical boilers, and according to all reports, with excellent results.

Possibilities of Electrochemistry.

In the Presidential address of Mr. J. W. Swan, delivered before the Society of Chemical Industry at Glasgow, and published in the *Electrician*, the subject of electrochemistry is discussed at length.

The application of electrochemical methods in commercial work is largely a question of power, and cheap power must be a necessity so long as electricity is generated from chemical energy. Mr. Swan shows that while water power is generally the cheapest, yet in some instances the first cost of installation is so heavy that the interest burden makes it as costly as steam. As to the problem of producing electricity direct from coal, it must be remembered that any such method would involve the use of some form of cell, and that, judging from present experience in the handling of batteries, any form of cell would demand a greater cost for attendance and inconvenience than its advantages would warrant. The real source of cheaper electricity appears to lie in cheaper motive power, possibly in the utilisation of waste furnace gases in internal combustion motors.

Given cheaper electricity, and the influences upon electrochemical industries may be predicted. Cheaper electricity means cheaper calcium carbide and acetylene; the electrical decomposition of brine, with soda as the by-product and chlorine as the principal product. It means the possible fixation of atmospheric nitrogen, as already shown by Sir William Crookes, and the direct production of nitric acid and of nitrates. Carborundum and artificial graphite become sufficiently cheap to displace natural competitors; aluminum falls in price to less than double that of copper by weight, and hence becomes cheaper per unit of electrical conductivity, and can displace the latter in many places as a conductor of current. These and many others must come with the advent of cheaper electricity, and will probably come in the very close future. Mr. Swan devoted attention to the importance of technical education in connection with the development of electrochemistry and its industrial applications, and urged the advancement of technical education, as one of the important objects of the society he was addressing.

Steam Turbine Vessels.

THE question of the adaptability of the steam turbine for marine service has been referred to many times in these columns, and to approaching completion of the King Edward, fitted with Parsons' steam turbines noted. We now have an account of the trials and regular running of this interesting vessel, and from reports in *Engineering* we give some abstract of the results.

The King Edward is 250 feet long and 30 feet wide, with a moulded depth of 10 feet 6 inches to the main deck, and 17 feet 9 inches to the promenade deck. She is designed for service on the Clyde, and with the exception of her propelling machinery, is similar to the best paddle steamers in the same service.

"The propelling machinery consists of three Parsons steam turbines working compound. These are placed side by side. In ordinary working, and when going ahead, steam is admitted from the boilers to the high-pressure turbine, where it is expanded five-fold. From thence it passes to the two low-pressure or wing turbines, placed one on each side, where it is expanded 25-fold, and then passes to the condensers. The total ratio of expansion is therefore no less than 125-fold. Each turbine has its own shafting; and on each of the wing shafts there are two propellers, while the central one carries only a single screw."

The wing motors alone are used with direct steam when manœuvring alongside a wharf, and there are small auxiliary turbines on the low-pressure wing turbine shafts for reversing purposes.

On the trial runs on the Firth of Clyde, a speed of 20.48 knots was registered, the mean revolutions being 740, and the boiler pressure being 150 pounds. Of course no indicator diagrams can be taken from this type of engine, but the horse power was estimated at 3,500 h. p.

The economical performance of the steam turbine has already been found, by trials of stationary engines under brake or dynamo load to be not greatly different from economical reciprocating engines, but as yet no economy tests of the *King Edward* have been made. During the regular running, however, it has been observed that the coal consumption is no greater, and possibly slightly less than other vessels of her class using reciprocating engines, and on this score the turbines appear to be satisfactory.

An important feature of turbine propulsion is the absence of vibration. The turbines themselves are entirely free from vibration and noise, and it is impossible on these points to tell whether they are running or not. On the *King Edward* a very slight vibration is felt directly astern, but this is due to the propellers, and not to the engines. This may possibly be eliminated, but as it now stands there is absolutely no vibration in the engines themselves.

Another feature to be considered in connection with turbines as marine motive power is the saving in weight. The weight of the motors, condensers, with water in them, steam pipes, auxiliaries connected with the propelling machinery, shafting, propellers, etc., is 66 tons. This is estimated to be about one-half the weight per indicated horse power of the average of the propelling machinery of paddle boats of a similar type. Owing to this light weight of machinery it has been possible to give a very fine shape to the hull. The model was tested very thoroughly in the experimental tank of the builders, Messrs. Denny, at Dumbarton, and the result is evident in the finely tapering lines at the bow and stern.

Altogether this installation should do much to demonstrate the adaptability of the steam turbine for vessels of a larger size than the torpedo boats and destroyers to which it has hitherto been fitted. Next we may expect the equipment of Channel steamers, and from that to transatlantic steamers is but a step.

Coal Dust Explosions in Collieries.

Explosions in colleries are generally due to the presence of firedamp, although the explosive nature of intimate mixtures of coal dust and air is well known. The relation of coal dust to permitted explosives in mines, however, has not had the attention which it deserves, and hence the paper of Mr. James Ashworth, in a recent issue of the *Colliery Guardian,* is of interest.

The direct occasion of Mr. Ashworth's paper was the explosion of coal dust in the Walthew House Colliery, due to the attempt of a fireman to break up a cog wheel with a charge of roburite, in order that it might the more readily be removed from the mine. The explosive employed in this case was one of the so-called flameless explosives, of high-class, having successfully withstood all government tests and being legalised for use in mining under well-known rules. Nevertheless, its use in this case was followed by a violent explosion, in which four men lost their lives, and the subsequent investigations established beyond question that the explosion was due to coal dust.

In examining the possible causes for the ignition of the coal dust by an explosive which had been found safe for use in the presence of firedamp. Mr. Ashworth advances a theory which appears sound, and which demands the attention of all who have to work in dusty mines. Assuming the absence of actual flame, or of firedamp, he shows that in this, and in other smilar cases, the explosions were due to the ignition of the dust by the intense heat produced by the sudden air compression produced by the force of the explosive.

That heat is caused by the compression of gases is well known. Wherever air is used under pressure means must be provided to carry away the heat. The cylinders and valve chests of air compressors are water-jacketed, to prevent the heat from attaining a point which would ignite the lubricants, while in certain petroleum motors the heat of compression is relied upon entirely for the ignition of the charge every stroke.

"But we must note that it is the speed with which the air is compressed that may cause the intense heat, and not necessarily the volume which is compressed; thus in the case of an explosion in the air receiver of a compressor, the pressure of the air was only 45 pounds per square inch, and yet the heat close up to the outlet valves was 550° F., and although the oil used for lubricating had a flash point of 600° F., yet by only slightly increasing the speed of the engine two explosions occurred in the short space of eighteen months. Gas is readily given off from coal dust, and it is merely necessary to accelerate the oxidation by heating the dust in contact with air to a temperature likely to be reached in compressing air to 58 pounds per square inch, to bring about the ignition of dust. Professor Bedson proved, when experimenting on coal dust after the explosion in the receiver and air pipes at Ryhope, that the ignition point of coal dust was between 291° and 320° F., and that also when coal dust was under pressure combustion was vivid and had a higher temperature than when the experiment was made under ordinary pressure."

These views receive practical confirmation in connection with the experiments made by Herr Diesel to use coal dust directly in cylinders of his internal-combustion motor. The heat of compression was found amply sufficient to ignite and maintain the coal dust in combustion without the use of any other igniting device. Diesel's experiments also showed that the temperature of ignition was materially lowered by compression, which is also in accordance with the observations upon colliery explosions.

"In connection with the Ryhope compressed air explosion there was another point which does not appear to have received any attention at the time, nor yet since, viz., that the explosion in the receiver started a wave of compression, which produced a sufficiently high temperature to cause the generation of combustible gases in the pipes in the shaft and roadway, and in this way the temperature and the pressure were increased until the wave of compression reached such a point of intensity that it caused an explosion which exerted stupendous effects at a distance of 400 yards from the receiver."

The importance of this question of possible ignition from compression should especially be considered in connection with dusty mines when it is remembered that while a temperature of about 667° C. is necessary to ignite firedamp, only 145° C. with pressure is necessary to ignite coal dust. It appears to be useless to attempt to prevent the presence of dust by sprinkling, as the presence of moisture adds to the force of the explosion.

The Transverse Strength of Ships.

Among the papers presented at the recent meeting of the Institution of Naval Architects may be mentioned one by Mr. J. Bruhn upon the transverse strength of ships, which, both from the importance of the subject and the manner of its treatment, demands review.

Nearly all the discussions of the strength of ships have been made with reference to the longitudinal strength, and indeed when the calculated strength of a vessel is mentioned it is always assumed to refer to the longitudinal strength. So far as the quantity of material used in construction is concerned, this is doubtless natural, since the longitudinal bending moments are so much larger than the transverse ones, as to have a far more important influence upon the material required.. When considerations of safety are taken into account, however, no one part of the ship can be considered of more importance than another, and if damage occurs, it is no excuse to say that the vessel was of ample strength longitudinally.

Mr. Bruhn proceeds to examine the subject graphically and analytically, and while we cannot go into the details of his analysis in this place, some idea of his method may be given.

Longitudinal girders present little scope for variation in design, and the breadth, depth, and form being practically given, the only opportunity for varying the strength lies in modifying the thickness of the plating. In the case of transverse framing, however, the efficiency, or strength, lightness, and compactness, of the structural arrangement, depends to a great extent upon the form and arrangement of the material. Since the case is more complicated than in the design of longitudinal framing, while at the same time greater variation is possible, it will be seen that the opportunities for the application of scientific principles are correspondingly greater.

Transverse stresses may be defined as those which act to change the form of the cross section of a ship. These are directly due to forces acting transversely and indirectly to forces acting longitudinally. These forces may be determined with a greater or less degree of accuracy, according to circumstances. The weights of structure and cargo, together with their reactions, due to rolling, pitching, or heaving can be closely determined; the weights exactly, and the reactions accurately by experiments in still water, or roughly by considering only the failures and successes of actual structures. Taking such a structure as a vessel floating freely in water, all the forces acting upon it can be determined when the conditions are known. In practice the forces must be based upon the assumption of the worst possible case which the vessel can be supposed to meet. The task of the designer then consists in apportioning the work of resisting these forces to the various parts of the structure.

Mr. Bruhn proceeds to investigate the problem by supposing a section of one frame space in length, cut out of a ship, and examining the forces necessary to keep it in equilibrium under the given conditions. In the case of a simple section, such as that of a small single-deck vessel, without pillars, floating freely in still water, the problem is a comparatively simple one. In order that the ring formed by the outline of the section shall be in equilibrium, the weight of the structure and the cargo, the pressure of the water, and the bending and direct stresses on the ring, must balance each other. The problem thus becomes one of statics, and is solved as such. When, however, the resistance of beams and framing are also to be considered, the problem becomes more complicated, and Mr. Bruhn considers the most direct method of solution to be that based on the principle of least work. This method, although largely applied to general framed structures since its introduction by Castigliano, has not heretofore been used in connection with the design of ships although it possesses many advantages for that purpose.

It is impossible to go into the mathematical details of the application of the method to the distribution of stresses in ship framings here, but its use is clearly shown by Mr. Bruhn in fully worked-out examples. The cases examined include designs with single decks and with two decks, with and without rows of pillars between the centre and the side, and the extension of the method to vessels with any number of decks and pillars is shown to be altogether practicable.

Among other things the analysis shows the important part performed by transverse bulkheads in increasing the athwartship strength.

Their effect, being transmitted to the frames through the shell plating, deck plating, and stringers, will prevent racking so long as the spacing is close enough to prevent the plating from bending appreciably.

The most important feature to be considered after the application of the method is understood, lies in the proper estimation of the forces. The original computations are made upon the basis of the steady pressure of the water when at rest. The stresses will necessarily be greater when a ship is at sea, rolling and subjected to blows from waves. The horizontal pressure of the water being by far the most important force acting on the frames of a vessel, it is desirable to ascertain as far as possible what it will be under the worst conditions met at sea. The experiments of Stevenson, made in connection with lighthouse construction showed blows as high as 3 to 3½ tons per square foot striking a rigid wall or rock. As the force of a blow cannot be stated, however, with any practical value unless the yield of the body struck be also given, these figures are hardly available. Mr. Bruhn estimates, from the strength of rudder-stocks which have been broken by striking seas, that the force may be safely taken as about .2 ton per square foot, but he suggests that experiments upon the subject be made.

The Measurement of High Temperatures.

In view of the increasing use of high temperatures in the arts it has become more and more imperative that some convenient and accurate method of measurement should be provided, and the solution of this problem has occupied the attention of many able investigators. Ever since the time of Wedgwood it has been realised that products which are obtained by the action of heat often have their value materially affected by comparatively small variations in the temperature to which they have been subjected, and apart from the interest which the question of the accurate determination of high temperatures possesses for the scientific investigator, it will thus be seen that the subject has a great technical and commercial importance.

The recent development of electric pyrometers shows that much has been done in that direction towards the definite solution of the problem, and hence the exposition of the construction and operation of these instruments in papers by Mr. W. Rosenhain, in recent issues of the *Electro-Chemist and Metallurgist* are of interest and value.

"Electric pyrometers may be divided into two classes, according to the electrical effect of heat upon which they depend. One class depends upon the effect of heat to raise the resistance of a wire; these are resistance pyrometers. The other class takes its indications from the current generated by heating one of a pair of junctions; these are the thermo-electric pyrometers. Each of these electrical effects of heat may utilised for the measurement of high temperatures in two ways. The resistance wire or the thermo-couple may either be placed directly in the furnace, at the very spot the temperature of which it is desired to determine, or it may be exposed only to the heat radiated by the body of which the temperature is to be measured. The former method is much more direct, sensitive, and satisfactory wherever it is available, but the difficulties with which it is attended increase rapidly when the temperature to be measured exceeds 1,300° C. For the excessively high temperatures met with in electric furnaces, however, the radiation method must be resorted to, as the most refractory materials are fused by such heat, with the sole exception of carbon. It may ultimately be possible to construct a thermo-electric junction of two varieties of carbon which will stand the heat of the electric arc, but so far no such couple is known. The measurements of these very high temperatures by radiation methods are unsatisfactory for a number of reasons, but chiefly because we cannot calibrate our instruments at these temperatures, except by extrapolation, which has to be carried so far as to render the results of very little value.

The electric resistance pyrometer, originally suggested by Dr. Siemens in 1871, consists of a platinum wire about a metre in length, and 0.1 mm. in diameter, wound about a cylinder of porcelain, and placed in a suitable position in the furnace. By making the hot platinum resistance a part of a battery circuit in parallel with a known resistance kept at a constant temperature, the variations in temperature would be indicated by the variations in resistance, the measurements being made either with a voltameter, or a galvanometer. A serious difficulty which soon appeared with this instrument was the variation in the resistance of platinum. Instead of remaining constant, the resistance increased after each heating, thus requiring the instrument to be re-calibrated after each using.

This difficulty has been largely obviated by Griffiths and Callendar, it having been found that perfectly pure platinum, completely protected from the chemical action of metallic vapours or the contact of clay or other siliceous matter in a reducing atmosphere, and properly insulated, will remain practically of constant resistance. The improved Griffiths and Callendar resistance pyrometer, with the ingenious recording apparatus of Professor Callendar, is now a commercial instrument, well adapted for many operations, but it is desirable that the resistance of platinum of high temperatures be more precisely determined than is now the case.

The thermo-electric pyrometer depends upon the fact that when two different metals are joined and heated at the point of junction an electric current is produced in the circuit of which they form a part. Such devices were studied by Becquerel, Regnault, Pouillet, and others, but it remained for Le Chatelier to produce a reliable instrument upon this principle. In the Le Chatelier pyrometer two wires, one of pure platinum and the other of platinum alloyed with 10 per cent. of rhodium are soldered together at one end, and inserted into a porcelain tube. The free ends are connected to a galvanometer, and the deflections measure the heat to which the wires are subjected.

Mr. Rosenhain discusses especially the Roberts-Austen pyrometer, which consists of the Le Chatelier thermo-electric couple, connected with a photographic recording device. A mirror on the galvanometer throws a beam of light upon a moving surface of sensitised paper, or in the more refined instruments for laboratory work, upon a sensitive photographic plate, thus recording every variation of current and temperature accurately.

By the use of very sensitive galvanometers, and a rapidly moving sensitive photographic plate in the recorder, together with the employment of a differential method of observation, Sir W. C. Roberts-Austen has obtained some remarkable records showing the arrest points and phenomena of recalescence in cooling metals.

Various practical difficulties, however, appear in connection with the practical use of electric pyrometers. The refractory substances used to protect the wires from the chemical action of vapours in furnaces becomes softened at temperatures above about 1,400 degrees C., and many insulating materials, as shown by Nernst, become electrolytes at high temperatures.

"With these difficulties before us, it must be admitted that the problem of obtaining continuous records of furnace temperatures much above 1,200 degrees C. is not yet satisfactorily solved; but the instruments that have been described are evidences of the valuable help that electrical science has given to the study of high temperatures and to the arts and industries involving their use."

The Limitations of Electric Traction.

In the introductory lecture of Cantor lectures on electric railways, recently delivered before the Society of Arts by Major Cardew, and published in the *Journal* of the society, there are given some interesting views as to the proper place for electric traction for railway transport.

"Under what conditions, and for what reasons does it cease to be preferable to the existing system of steam locomotion?

"The two systems differ so radically, inasmuch as in steam locomotion the power is entirely self contained, whereas the electric train derives its propelling power from an outside source, that we instinctively feel that there must be a field for each method, especially since the self-contained system has beaten all systems analogous to the electric under all conditions of traffic, and it is only in consequence of its great superiority to any other known system of transmission of power that electricity can claim to compete with steam in the field of railway working."

The matter may be considered from two viewpoints: that of the travelling public and that of the railway companies. The traveller can hope for no very great advantage from the substitution of electricity for steam on long distance express journeys. There might be less discomfort in tunnels and a little time might be saved in stops, but otherwise there is little or nothing to be gained. It has been claimed that greater speeds can be attained with electric driving than with steam, and while this is true, yet it is doubtful whether speeds of 100 to 120 miles an hour can be made to pay, within the limits of the British Isles.

"When we regard the traffic arrangements on the lines communicating between important towns not exceeding 100 miles apart and their branches, however, the possibilities of improvement from the introduction of electric traction and of the new methods of working traffic which must accompany the change, become far more considerable."

The two methods differ entirely in principle. The problem of conveying a given number of passengers between two places is economically solved with steam traction by means of a limited number of heavy trains at considerable intervals; while with electric traction the most advantageous method is that of light trains at frequent intervals. For short journeys, say of two hours or less, the advantages of a frequent service at fixed intervals are very considerable. The electric system, however, requires a totally different method of operation from steam locomotion. It involves not only the electrifying of the line, but also the electrifying of the traffic arrangements. It is these latter changes which doubtless cause many managements to hesitate, rather than the engineering details of the change of motive power. If the public will respond promptly and fully, the cost of the greatly enhanced travelling facilities, would not stand in the way, but as it is, many directorates hesitate to take the plunge.

"Steam traffic has been evolved from the stage coach, and bears the unmistakable impress of its descent. Electric traction tends towards the ideal of the continuously moving platform."

Viewed from the standpoint of the railway companies, the whole question is resolved into one of finance. The conditions of electric traction point to greatly increased receipts, due to improved service and increased earning capacity. With this, however, comes greatly increased expenditure; partly due to capital expense, which can be easily computed, but largely due to increased working cost, a less definite item.

Major Cardew examines at length the points in favour of electricity as a motive power for a frequent service of light trains, taking his data largely from the paper of Mr. W. Langdon before the Institution of Mechanical Engineers, reviewed in these columns in January 1901, as well as the paper of Mr. Boynton before the American Institute of Electrical Engineers, reviewed here in April 1900. The general conclusion is undoubtedly in favour of electric traction under the conditions above stated, i. e., for journeys of about 2 hours or less in time, where the traffic will warrant the running of frequent light trains.

It must not be forgotten that the advantages gained by the high speed on the road, are often neutralised by the waste of time involved to the traveller by the system of trains from single terminals at long intervals. The loss of time, due to the distraction from business affairs, necessitated by the catching of a particular train, is entirely avoided by the knowledge that connection may be had every 10 or 15 minutes at a neighbouring station. It is the actual time between the passenger's home and destination, not between the railway terminals, which really counts.

The electric railway may never supersede the steam railway for long-distance express service, but for inter-urban service, within 100 miles distance, it will probably displace steam as completely as it has already displaced horse traction for municipal and suburban tramways.

REVIEW OF THE CONTINENTAL PRESS

Water-Tube Boiler Connections.

One of the most important features in water-tube boiler design is the manner in which the tubes are connected to the collectors and water drums, and upon the method of connection employed depends to a great extent the important features of safety, strength, circulation, and ease of assemblage and repair. For this reason a paper by M. C. Walckenaer, in a recent issue of the *Revue de Mécanique,* demands attention, treating as it does, upon the development of the various methods now in use.

Water-tube boilers, as the name implies, consists mainly of assemblages of tubes filled with water and exposed to the action of fire and heated gases. In them the steam is generated, and every facility should be provided for the escape of the steam to the point where it is delivered for use, equal facility being given to the access of water. It is evident that connections for tubes for such service have to fulfil severe requirements. The joints are many and close together, and commercial economy demands that the cost shall not be great. Steam pressures are creeping steadily upward, and 250 pounds per square inch is a not uncommon requirement, while at the same time rapid firing and sudden demands for steam make expansion and contraction strains frequent and severe. The necessity for prompt and convenient replacement of burst or leaky tubes demands a joint which can be easily broken and re-made, and, what is still more difficult, will be as tight as ever when re-made. All these requirements must be met, not only when the work is done in the works of the maker by skilled mechanics using special tools, but also, and frequently, in the stokehold of a vessel, many miles from port and with such help as can be obtained under such conditions, or, even in the midst of battle at a time when the fate of the engagement or the vessel may depend upon the promptness with which the joint can be handled.

M. Walckenaer begins with the Collet joint, a predecessor of the Niclausse system, this being a concentric tube system in which a taper joint was made between the front end of the tube and the collector by means of a long through-bolt, this bolt also serving the make the connection for the caps at each end, and apparently suggested by the similar bolts used long before on the Harrison system of cast-iron spheres. This was subsequently replaced by a short bolt engaging with sockets in the forward end of the tube, the back end being closed entirely, or fitted with a screwed cap.

The desirability of providing for the withdrawal of the tubes from the front, however, caused this arrangement to be reversed in the present form of the Niclausse boiler, and the sleeves are now forced in from the front, one yoke and bolt serving for two adjacent sets of tubes. In this design the tubes were originally attached to the sleeves by a screw joint, but there have been several accidents due to the separation at the screwed joint, and in the latest pattern the sleeve, with the two conical joint-surfaces, is formed in one piece with the seamless tube. The rear end of the Niclausse tube is closed by a screwed cap, but as this joint is not exposed to the action of the fire, no difficulty is apprehended at that point and no failures have been reported.

The above methods all relate to boilers having tubes connected to the collectors at but one end, and provided with internal circulating tubes on the Field principle, and they are manifestly unsuited for tubes connected at both ends. The Belleville boiler, one of the oldest in this matter, M. Belleville having been experimenting since 1856, uses screwed joints, the steel connecting boxes being fitted with a thread of 2.5 mm. pitch, while the screw-thread on the tubes is 2.54 mm. pitch, this slight difference in pitch insuring a tight joint. A back nut is also used on the tube, red lead being applied before screwing up. This sort of a joint is difficult to disconnect after having once been properly made up, and in the Belleville boiler it is customary to remove an entire element and replace it with a new one, when any tube reveals defects. If a single tube must be replaced the back nut is usually cut off, and even then the tight differential joint is sometimes hard to disconnect.

Expanded joints are generally used in the small-tube express boilers, and also in some of the large-tube boilers such as the Babcock & Wilcox, De Naeyer, and others. These joints, made by expanding the ends of the tubes by the use of a roller expanding tool until a shoulder is formed against the metal of the collector or header, have long been employed in the construction of multitubular "tank" boilers, and although they do not meet wtih the full approval of M. Walckenaer they appear to be the most practical form at present in use, although something better is undoubtedly to be desired. Single tubes can be cut out and new ones expanded into the same holes, and if the work is intelligently done the new job will be as good as the old one. This may not be saying a great deal, but it is more than can be said of screwed or taper joints, or in fact of any form of joint now known, except the finished metal-to-metal joint, used in some older types of boilers and now abandoned because of its cost.

M. Walckenaer discusses the various forms of joints used for caps, and his paper is a thorough résumé of this most important detail of water-tube boiler design, and it is to be hoped that it will stimulate steam engineers to effect further improvements in a ripe field.

The Iron Industry of the Southern Urals.

The development of Russian metallurgical industries continues to fill an important portion of the field of technical interest, and from a paper presented before the Societé des Ingénieurs Civils de France by M. Alexandre Gouvy, and published in the *Mémoires* of the society we take some account of the methods and products of the iron industry of the southern Urals.

M. Gouvy, who is the director of the Komarovo iron mines and furnaces near Avzianopetrovsk, is especially well fitted to discuss the work of this important district and to show its possibilities and needs.

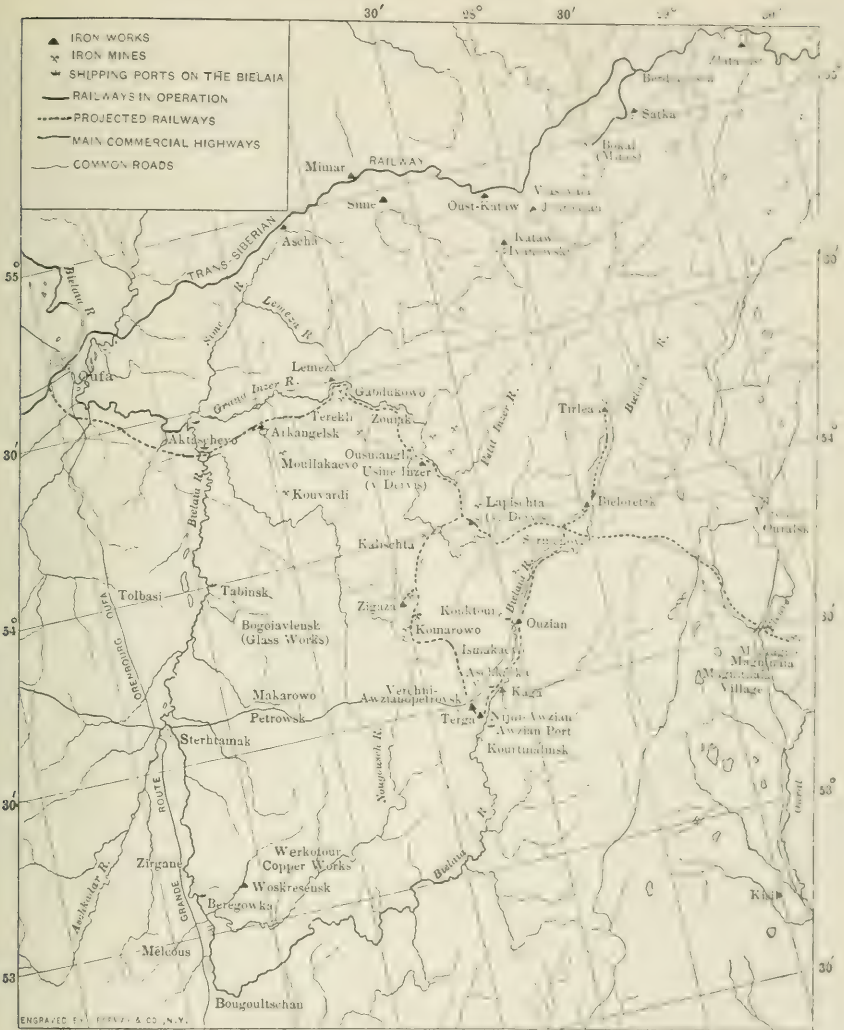
The Southern Ural comprises that portion situated between the 53rd and 55th degrees of latitude, south of the main line of the Trans-Siberian railway, running from Samara to Tcheliabinsk. In considering this important region it must be remembered that the conditions are wholly different from those obtaining in the central and northern Usal districts. There are no railways in the southern Urals, and the only available fuel is wood from the Bashkir forests, while in the more northern sections the mines and iron works are in connection with railways and navigable rivers, and are operated in connection with proprietary forests, or with forests held under long government leases As a result of this isolation, the conditions vary at each furnace, and the cost of the product fluctuates with the weather, with the price of oats and corn, and with the supply of labour and of horses.

Notwithstanding these difficulties this inaccessible region at present maintains 17 blast furnaces of a capacity of 6,000 to 12,000 tons per year, the total being more than 150,000 tons of pig iron.

M. Gouvy discusses in detail the methods of manufacture and the difficulties with which the iron works have to contend, mainly for the purpose of showing how vastly the output of the region would be increased if suitable transportation facilities were afforded. We can only give space here to a brief résumé of the present methods. as the important feature of his presentation of the subject lies in the exhibit which it gives of the wealth of the district and its future iron-producing capabilities.

The geographical location of the various iron works in the district is shown on the map, as well as the iron mines and the present limited means of transport. The map shows also the existing railway communications, and the proposed lines, which if completed will open up one of the richest iron mining sections in Europe.

The ores of the district are mainly brown hematite, found in strata ranging from 60 to 120 metres in thickness, and



THE IRON DISTRICT OF THE SOUTHERN URALS.

readily uncovered and worked from the surface.. The gangue is schist and clay, and roasting is found necessary before the ore is suitable for the furnace. In the western portion, close to the Siberian border is found the mountain Magnitnaia, consisting almost wholly of a very rich magnetite, containing 63 to 65 per cent. of iron. This ore has as yet been used only by the Bieloretzk furnace, solely because of the difficulties of transport to other furnaces, and indeed the riches of this section are as yet very imperfectly realised. The brown hematite is low in phosphorus (0.02 to 0.06 per cent.) and contains about 53 per cent. of iron.

These ores are at present worked entirely by manual labour, the Russian peasants coming from the villages, sometimes from a distance, bringing their families, horses and sledges, the men digging out the ore, the children leading the horses and sledges from the mines to the furnaces, while the women work in the woods. With these crude methods, the ore costs from 3.13 to 5.44 francs per ton, of which 60 to 80 per cent. is due to mining and hauling, and could be enormously reduced by the employment of steam shovels and railway transport.

The fuel is invariably charcoal, made in the surrounding woods, from the pine and birch, the beech, so generally employed in making charcoal in the iron districts of Hungary, being almost entirely absent. The charcoal burning is mainly the work of the Bashkirs, the semi-Tartar people who form the principal population of the region. The greater portion of the forests belong to these people, having been ceded to them by Catherine II, under the jurisdiction of the forestry department of the government, but the extent and nature of the region makes it practically impossible for the government to exercise any control, and great waste continues in the exploitation. The wood is charred in ovens, or in heaps and hauled to the furnaces on sledges in a manner similar to the ore, the cost necessarily varying greatly according to local conditions.

The furnaces are of moderate size, depending upon the capability of the charcoal to sustain a burden, and are constructed mainly of local materials, the cost of transport having an important bearing upon everything. This same question of transport has influenced the character of the machinery, the blowing engines, mainly of German make, being of high speed in order to reduce weight, and sectional boilers, of the Babcock & Wilcox type, being used.

At the present time the traffic of this important iron region is entirely confined to the river Bielaia, with the exception of a trifling portion from Tirlean, carried on camels. The shipments on the Bielaia are made once a year as soon as possible after the melting of the snows, usually in April, the barges being constructed for each voyage, and being broken up and sold for building or fire-wood when the ports of destination are reached. These barges are 40 to 50 metres long and 10 metres wide, and in the upper waters of the Bielaia carry 10,000 to 15,000 poods (16 to 25 tons), while below Beregovka, loads of 40,000 poods (about 65 tons) may be carried. For these reasons the works at Kaga-Bieloretzk and Avzianopetrovsk are obliged to haul a portion of their output as far as Sterlitamak or Tabinsk, in order to complete the loading of their barges.

A number of railway projects have been made to open up this important region, and the proposed routes are indicated on the map. Especially is it desirable that the mines at Magnitnaia be placed in rail connection with central and western Russia. From Oufa, on the Trans-Siberian Railway, to Magnitnaia is 350 versts, about 232 miles, while with the branch railways to the various mines and furnaces the total length of railway required will reach 500 versts, or 330 miles. The cost of the road is estimated at about 37,500,000 roubles, an amount probably only obtainable by government assistance, but the immense gain to the available riches of the empire resulting from the opening of this important region appears to make the expenditure ultimately advisable.

Tests of Masonry Piers.

Several years ago the Austrian Society of Engineers and Architects made a very important series of tests of full-sized arches of brick, stone, and concrete, and the report of these trials, together with the accompanying analysis, proved a most valuable contribution to engineering literature. This work has now been supplemented by some important tests upon the strength of masonry piers, the tests being made under the supervision of the same committee which conducted the arch tests, the results being published in a recent issue of the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines.*

The tests were made in all cases upon piers one-half metre square in cross section and one metre in height, the pressure being applied by means of a 1,200 ton hydraulic press at the Poldihütte at Kladno. The report gives an illustrated description of this press, which was originally constructed for forging steel, and which had already been employed for testing on similar work by Herr Ludwig Huss, former member of the arch-test committee. The press was carefuly calibrated to determine its internal frictional resistances, and the gauges upon which the pressures were read being also calibrated it was possible to determine the true pressure upon the test piers very closely.

Various kinds of piers were subjected to the tests, for the details of which the reader must be referred to the original report. Among those tested were piers of granite, sandstone, concrete, common and reinforced, and brick. The reinforced concrete construction was tested in two different types, one having imbedded in it vertical wire rods 12 mm. in diameter, and the other containing wire cages, of which the principal members were parallel to the surfaces of pressure. In all cases much care was taken to insure that the load should be central, with the exception of certain tests which were purposely made to determine the effect of eccentric loading. The records were taken at the moment of the appearance of the first cracks, and at the time of ultimate crushing, these results being fully tabulated in the report.

The tables are very full in details and but a few results can be given here. Thus a pier of hard bricks laid in Portland cement sustained, after six months, a load of 1,365 pounds per square inch before cracks appeared, and crushed under 2,275 pounds. Granite blocks, laid in Portland cement, crushed under 8,100 pounds per square inch, while piers of sandstone rubble, laid in Portland cement, showed cracks under a load of 2,750 pounds, and crushed under 3,200 pounds.

The most interesting tests, however, were those which showed the resistance of ordinary and reinforced concrete piers. A pier of solid concrete after 3½ months, crushed under 1,780 pounds per square inch, the rupture taking place almost without warning cracks. A similar pier, reinforced by the insertion of vertical wire rods held together by circumferential bands, and tested also after 3½ months, stood a pressure of 2,470 pounds per square inch before the appearance of cracks, and crushed only after the application of a load of 3,800 pounds. Even then the pier did not altogether give way, the core remaining partially unbroken. The results of these tests showed the importance of placing the metal reinforcement where it can act to the best advantage. A moderate increase in the strength of the circumferential bands, would have added greatly to the strength of the whole pier without adding appreciably to the cost, while the large margin of strength remaining after the appearance of the first cracks shows how structures constructed on this principle may be made free from sudden disaster.

The care with which these tests were made, and the fullness with which the results are recorded, render this report a valuable document, worthy of association with the large report of the same committee upon arch tests, and it adds one more to the many contributions to engineering knowledge by the Austrian society.

Binary Vapour Engines.

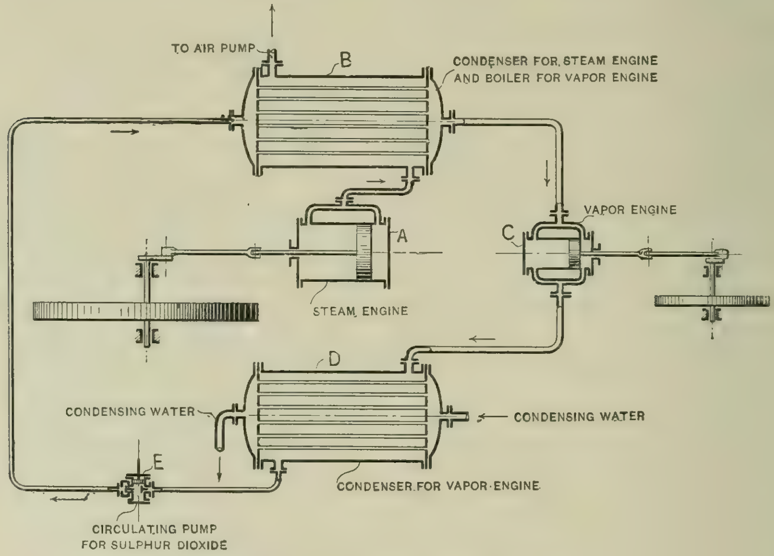
The recent experiments of Professor Josse, of the Charlottenburg Royal Technical High School, upon his improved form of binary vapour engine, have attracted much attention, and the whole subject is one which demands discussion in view of the prominence which has been given to it of late.

The idea of using the heat contained in the exhaust of a steam engine to vaporise a more volatile liquid than water, the second vapour to be employed in a second engine, appears to be due to Sir Humphrey Davy, but he made no attempts to put the idea into practice.

In 1830, Ainger suggested the use of ether as a secondary liquid in connection with steam, and about 1850 du Trembley constructed several such engines, and demonstrated their operative success in vessels plying on the Mediterranean.

Briefly, the principle of the binary vapour engine is that of delivering the exhaust steam from a steam engine into a surface condenser, the cooling surface of which is in contact with the volatile liquid. The steam is condensed, thus producing a vacuum for the steam engine, while the volatile liquid is vapourised and its vapour produces sufficient pressure to run a second engine. The exhaust from the second engine is condensed in a surface condenser, using water as the cooling agent, and the condensed liquid is pumped back again into the vessel in which it was vapourised.

Du Trembley made several engines on this plan, maintaining that all the power obtained from the ether engine which he used was clear gain, having been generated from the waste heat in the exhaust of the steam engine. In view of the non-economical character of the steam engines with which he experimented, there was doubtless sufficient waste energy in the exhaust to make it worth utilising, but the mechanical difficulties connected with the ether engine, such as leakage, defective stuffing boxes, etc., made the system impracticable, and the report of the French Government Commission, given in abstract in Bourne's "Steam Engine," shows the causes which led to the abandonment of the method at that time.

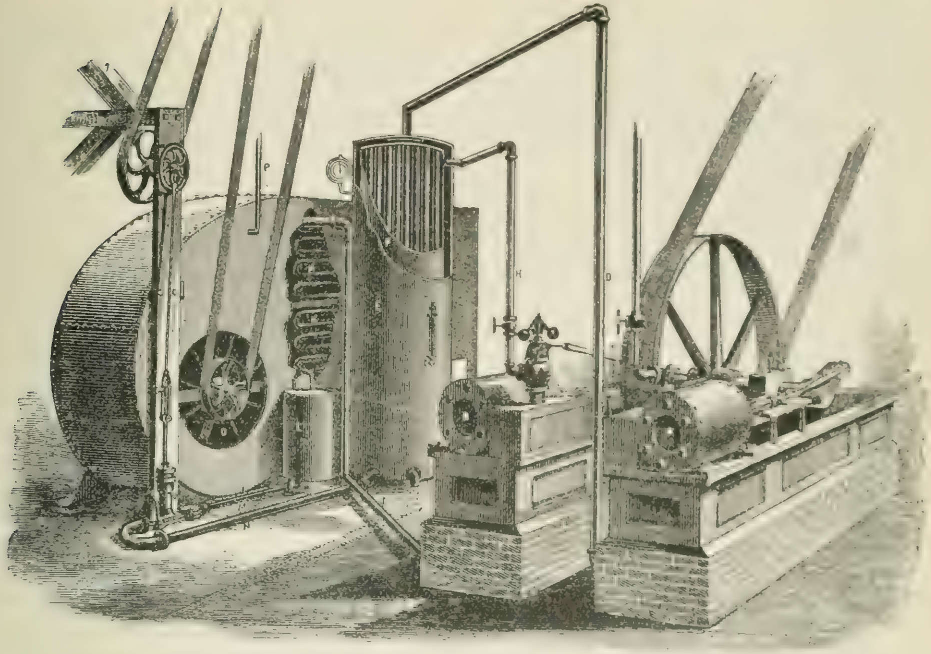

TO AIR PUMP
B
CONDENSER FOR STEAM ENGINE AND BOILER FOR VAPOR ENGINE
A
STEAM ENGINE
C
VAPOR ENGINE
D
CONDENSING WATER
CONDENSING WATER
E
CONDENSER FOR VAPOR ENGINE
CIRCULATING PUMP FOR SULPHUR DIOXIDE

SCHEME OF THE JOSSE BINARY ENGINE.

Professor Rankine, in his classical treatise on the steam engine, examines the theory of the binary vapour engine at length, with a study of indicator diagrams; taking his data for the ether engine from M. Gouin's report of the performance of the du Trembley engines on the steamship "Brésil," in which a minimum fuel consumption of 2.44 pounds of coal per horsepower-hour was attained. His conclusion may be quoted here: "The binary engine is not more economical than steam engines designed with due regard to economy of fuel; but by the addition of an ether engine, a wasteful steam engine may be converted into an economical binary engine. The same amount of additional energy which is obtained by the addition of an ether engine to a steam engine might also be obtained by continuing the expansion of the steam sufficiently far, provided a sufficiently low back pressure could be insured; but this might require in some cases a cylinder so large as to be more costly than the binary engine."

The idea then remained dormant until about 1870, when it reappeared in America as the Ellis Combined Vapor Engine. The principal difference between the Ellis system and its predecessor lay in the use of bisulphide of carbon instead of ether, but the principle remained unchanged. Ellis and his associates showed much ingenuity in the working out of details, and several engines were built and operated with success, but while the steam consumption of ordinary engines to which the bisulphide engine was connected, showed a decided economy, in no case were better results attained than with the use of steam engines working over the same range of temperature. The system was abandoned, we believe, after a disastrous explosion of bisulphide vapour.

During the past few years experiments have been made by Professor Josse at Berlin, with a binary engine in which sulphur dioxide is employed as the secondary vapourised liquid. Professor Josse has published a very interesting account of his experiments on apparatus in the *Mittheilungen aus den Maschinen-Laboratorium der Kgl. Tech. Hochschule zu Berlin,* and as a company has been organised for the development of his ideas on a commercial scale, the subject demands re-discussion.



THE ELLIS BINARY ENGINE, AS OPERATED IN 1873.

Since the experiments of du Trembley and of Ellis, much experience has been gained in handling vapours of volatile liquids, such as sulphur dioxide and ammonia, in connection with refrigerating machinery, and this has rendered it possible to overcome constructive difficulties which gave the earlier experimenters much trouble. In other respects the apparatus of Professor Josse is surprisingly similar to that of Mr. Ellis, so much so that one must express admiration at the work of the earlier engineer, who, more than 30 years before, showed such a full appreciation of the nature and difficulties of the problem.

The general arrangement of the Josse apparatus at the Charlottenburg Technical High School is well shown in the diagram, which practically explains itself. The steam engine was a triple expansion engine, working with steam superheated 300° C., and developing about 150 h. p., with a steam consumption of about 11.15 pounds per h. p. hour. The sulphur dioxide engine added about 33 per cent. to this, and gave a total steam consumption of about 8.34 pounds per h. p. hour.

While this is an excellent showing for a combination of such a moderate total power, yet, after all, it is no lower than has been obtained with modern steam engines of about the same power, using superheated steam. Thus the Schmidt compound engine, using steam superheated only 150° C., has shown a steam consumption of only 8.36 pounds of steam per h. p. hour, without any of the complication of the binary vapour engine, and the added cost of the superheater is hardly as much as that of the second engine and condenser, and indeed at Charlottenburg the superheating apparatus was also used.

The opinion of Rankine, therefore, still holds good, and the economy of the binary vapour engine is about the same as that of the most economical steam engines without the use of the second liquid and engine. Professor Josse gives examples of the manner in which the sulphur dioxide engine has been used advantageously to add to the power and economy of existing engines which were not giving the highest results, and it is in this field that his apparatus may look for its commercial results rather than in the installation of new plants. This again is in full accordance with the opinion of Rankine, quoted above. As a matter of historical interest we reproduce the illustration of the apparatus of Ellis, taken from his pamphlet of 1873, showing it as it was running and tested at that time. It is interesting to note the close resemblance between the two systems, and also to observe that Ellis used the evaporative condenser in order to economise condensing water, a device only now coming into use in connection with steam engines.

Modern Turbine Construction.

With the development of the electrical transmission of power has come a great increase in the utilisation of water power, and in no country has this been more noticeable than in Switzerland. The review, therefore, of the turbines and regulators, exhibited at the Paris Exposition, recently appearing in successive issues of the *Schweizerische Bauzeitung* from the pen of Professor Franz Prásil, and now issued as a *Sonderabdruck* of that journal, demands notice at this time.

It is difficult to give a review of this character a form altogether different from that of a mechanical catalogue, but there are certain principles which can be discussed all the better because of the presence of concrete examples, and in this case the most has been made of the opportunity.

Broadly, the wheels exhibited may be divided into three classes: turbines for low and moderate heads, these being almost all designed on the Francis model, with slight modifications; turbines for medium and high heads, on the Girard type; and turbines for high heads on the Pelton type. For the first class, the gates being large and heavy, the regulators are nearly all operated by means of auxiliary motors, controlled by centrifugal governors. The auxiliary motors are in some cases hydraulic cylinders operated by the direct pressure of the water, but in most instances derive their power from the shaft of the turbine itself. The centrifugal governor throws into gear a screw or worm-wheel movement, in either direction, according as the speed is to be increased or diminished, or else it is connected to a pawl and ratchet gear which acts in a similar manner. This form of regulator shows a tendency to overrun, thus making too great a correction, and hence it is provided with a differential gear, which acts to throw the auxiliary power out of gear promptly unless followed up by the governor; and by a careful regulation of the relative action of the two portions of the differential connection, overrunning can be almost entirely avoided. Modifications of this idea appear in many of the governors exhibited, the details of construction varying, but the principle remaining unchanged.

An interesting form of auxiliary regulating apparatus of a different principle is found in the Rüsch-Sendtner resistance regulator. This consists of a centrifugal pump, driven by the turbine and delivering water into a chamber from which it takes it again, thus performing little or no work under ordinary conditions. The governor operates a throttle valve in the discharge passage of the pump, thus creating resistance when the wheel tends to run fast and acting as a hydraulic brake to check its speed, this resistance being removed as soon as the speed of the turbine returns to normal. The action is similar to that of the rheostat in electrical regulation.

Girard and Pelton wheels are generally regulated by opening or closing the nozzles, and several ingenious devices are shown by which the contraction of the nozzle is effected without the production of any sudden change of section which might cause excessive friction and eddying, and consequent loss of efficiency. No mention is made of the ingenious method of Cassel for dividing the buckets of the Pelton wheel and causing the two halves to approach or separate, permitting a portion of the jet to pass between the sections. While a close regulation may be secured by varying the opening of the nozzle, this necessarily acts to produce a varying pressure in the pipe line, and serious shocks are apt to occur.

In closing his review, Professor Prásil remarks: "Turbine construction, although of European origin, shows greatly the influence of American ideas, but at the same time the solution of the exact details of form and proportion, as well as of the problems connected with speed regulation, upon fundamental scientific principles, has been mainly effected by European engineers."

REVIEW OF THE AMERICAN PRESS

Engineering Education.

A GREAT deal has been said of late about the influence of technical and scientific education upon the commercial and industrial development of a nation. Doubtless there has been some exaggerated talk, and also some unwarranted assertions, but anyone who will take the trouble to compare the methods in vogue in that applied science which constitutes engineering at the present day with those followed say, twenty-five years ago, cannot help observing the changes which have been wrought by the entrance of the technically educated engineer into many important fields of work.

Apart from the direct utilitarian value of an engineering education, there is to be considered the so-called "cultural" value, and it is this phase of the question which was discussed in the recent presidential address of Professor E. O. Marvin before the Society for the Promotion of Engineering Education.

Formerly it was supposed that a broad culture could be obtained only by the acquirement of a so-called liberal education; an education which was really far from being really liberal or broad, and was rather confined within decidedly narrow limits of thought and action. Culture is not a thing to be easily defined even where it can be readily identified. To a great extent it is an individual quality, but it is also a quality to be developed by education.

The man of culture must be a thinking and reflecting being, and in engineering training this important faculty can best be obtained by avoiding rush and hurry in the preliminary work. Overcrowding, together with instruction in empirical methods, and short cuts may give a certain degree of facility which is fatal to correct and mature habits of thought.

Very important, too, is the cultivation of the judicial faculty. Honesty of thought is really nowhere so important as in engineering work, and in no branch of work is sham so difficult to conceal. Shiftlessness of thought and action may frequently be glossed over, or covered up in other lines of life, but metal and stone are difficult things to deceive, and the laws of Nature will not be broken; on the contrary, he who tries to break them will in the end find that they will break him. This, then should be the aim of every teacher; to see to it that all standards are based on sound principles of right and wrong, of truth and falsity.

There can be no true culture for a man who does not work.

"A man expresses himself through his work, and whether he will or no he thus discloses to all who know him his own peculiar qualities. It is this intensity of application, this concentration of purpose and directness of aim that gets the world's work done. Here in early years the engineering student has the advantage of the student in arts. Study for knowledge's sake may be stimulating to the few, but for the many there is needed the goal of a special calling to secure the close application that results in ability to concentrate one's energy to the attainment of a certain end." As has been well said already upon the same subject: "It is better to know what to do and how to do it, than merely to know what has been done and who did it."

With special knowledge is also needed a breadth of view, a poise which enables a man to see things in their right relations and due proportions. Possessing such a faculty a man can better understand the motives that underlie other men's actions, and use them to suit his own purpose. He will be more apt rightly to interpret the new movements in the world of thought or action, and can seize opportunity for a personal advantage or a larger sphere of service before others see that there is such.

The importance to the engineer of mathematics and physical science is well understood, but these must not stand in the way of a broad general training. There are other things to be dealt with besides materials and physical laws, and engineers have also to manage men and matters of finance. "If they are rightly to influence those whose capital they are to expend they must be able to meet them socially and intellectually, to discuss intelligently matters outside of the pale of strictly professional life. Evidence of professional ability and skill is of course first demanded, but breadth of culture creates an added confidence in the wisdom of the conclusions reached and the advice given.

In addition to the ability to form correct judgments must be added the capacity to make a skilful and correct presentation of them in well-chosen and fitting English. This ability cannot be taught by training in the writing of compositions, themes, reports, etc., alone; it must in great part be absorbed by an early and habitual reading of the best that has been written in all lines of thought.

"As one looks forward ten or twenty years and attempts from present tendencies to forecast the work and social standing of engineers, he must see that the profession will be doing a larger work and exerting a greater influence. Further, that an engineering training will be more and more recognized as the one best fitted to lead to positions of an executive nature in connection with industrial enterprises and in the administration of public works. Everywhere will be demanded expert skill, sound judgment and broad views, primarily because these will be found economical."

The Brooklyn Bridge.

The recent breakage of certain of the suspender rods and bands on the great suspension bridge between New York and Brooklyn has been prolific of numerous articles in the technical and daily press and the details of the subject are given at length in such journals as *Engineering News*, the *Iron Age*, the *Scientific American*, etc.

For a general examination of the subject doubtless the best statement of the occurrence is that of the chief engineer of the bridge, Mr. C. C. Martin, as contained in his report to the Commissioner of Bridges. As is well known, the bridge has four great suspension cables, passing over masonry towers, and provided with deep shore anchorages. The roadway is carried upon a truss system, suspended from the main cables by cables and suspender rods. In reporting upon the breaks, Mr. Martin said:

"Around the cables are placed steel cable bands, which are 5 inches wide and ½ inch thick. These are placed at a horizontal distance of 7½ feet apart. Connected to these, near the center of the main span of the bridge, on each cable, are 2½-inch steel suspension rods; all of the other suspenders on the main span are made of steel wire ropes 1¾ inches in diameter.

"The object of these suspender rods and ropes is to connect the transverse girders of the floor system of the bridge to the cables, which ultimately carry the weight of the bridge with its load.

"On Wednesday afternoon, July 24, it was discovered that seven of these suspension rods and two cable bands were broken, and traffic on the easterly half of the bridge was suspended. On account of the expansion and contraction of the trusses of the bridge there is a longitudinal maximum movement at the slip joints of about 7 inches, and as this movement takes place in the truss, to which the floor beams and the lower ends of the suspender rods are attached, and does not occur in the cable to which the upper ends of these rods are attached, the result is that the lower ends of the rods move backward and forward as the truss expands or contracts.

"In order to provide for this a steel trunnion block was introduced into this connection, which permitted a rolling motion without producing cross strains in the rods. These cast steel trunnion blocks are 5¼ inches deep, the rods passing through them freely, and a nut was placed beneath the block to hold the whole in place. Examination shows that all of the broken rods are broken in these blocks, and entirely out of sight; until enough of them had been broken to allow the cable to lift or the floor to settle sufficiently for the broken ends of the rods to come into sight, nothing would be known of the break.

"An examination of the fracture of two of the rods indicates unmistakably that they have been broken for a long time. All of the remaining suspender rods on this cable and on the other three cables have been carefully re-examined, and they are in perfect order. As to the broken cable bands, there are 1,700 of them around the cables on the bridge, and it is quite possible, notwithstanding the rigid inspection to which they were subjected before they were put in place, that occasionally a defective band may have been used. Constant inspection since the bridge has been in use has detected a few, and these have been replaced without in any way affecting the strength of the bridge or impeding traffic.

"In my judgment the cause of the present breaking of several of the suspender rods is as follows: As I have said before, two of the broken rods show old breaks—one much older than the other—as indicated by the broken ends of the rods. One rod having broken, would throw additional strains on those adjoining it, and in the course of time these would give way, and the process would naturally continue unless the broken rods were replaced.

"The fact that the rods on all of the other cables are sound would seem to indicate that my theory is correct, and that the fact that one rod—in all respects like all of the others, as far as can be seen—broke long in advance of the others, or that it broke at all would seem to indicate that it was originally defective.

"The bridge is now in perfect working order and is entirely safe."

Accepting this official statement, the whole subject has been discussed from two standpoints—that of placing the true cause of the breaks, and that of providing against its occurrence in the future. So far as the cause of the breaks is concerned, some criticism has been made, and apparently with reason, upon the statement that the material was originally defective in one of the suspender rods. It hardly appears reasonable that nine defective pieces could have been accidentally grouped next to each other, and at precisely the spot where they would be subjected to the most severe duty, although naturally the breaking of one defective rod would throw greater stress upon the adjacent rods. It is hardly good engineering to admit that until enough rods "had been broken to allow the cable to lift or the floor to settle sufficiently for the broken ends of the rods to come into sight, nothing would be known of the break." If breaks cannot be detected until such serious consequences become apparent something surely is wrong, and as has been suggested a tap of a hammer would have revealed to the experienced ear the fact that a suspender rod was no longer under tension.

However much defects in material or in constructive detail may have been responsible for the breaks, there seems to be little doubt that a severe and continual inspection, such as this important structure ought surely to have had from its opening day, would have detected the first of these breaks, and prevented the extension of the accident. The marked reticence of the authorities concerning the methods and severity of inspection is in itself significant on this point.

So far as a prevention of the recurrence of the breaks is concerned, this will probably be made by substituting roller bearings under the suspension points, instead of using the hinged joints. Various methods of introducing such bearings have been suggested and the problem offers no difficulty.

The fact that the bridge has been gradually loaded far beyond the original provision is freely admitted, and as the additional load has been placed gradually in the form of rails, trolley gear, pipes, wires, cables, etc., its magnitude has hardly been realized; it has been estimated at 10 to 15 per cent. in excess of the original load. Since the cables are amply strong this can be provided for by strengthening the road structure, and this, with continual and rigid inspection, should be sufficient to maintain the great bridge in safe condition.

Drawing Room Systems.

VARIOUS papers and discussions have appeared of late concerning systems for the classification and arrangement of drawings of machines and machine parts, but many systems which have been found satisfactory in the shops in which they originated, are found lacking when introduced into other establishments. An interesting paper, treating of the whole subject from a general point of view, by Mr. S. L. G. Knox, appears in a recent issue of the *American Machinist,* from which some abstracts are here made.

In the small shop, where machines are built, rather than manufactured, and where the drawings are not considered in connection with any machine other than that for which they were originally made, the simplest and cheapest plan is as follows: Make the drawings to as small a scale and on as few sheets as practicable, and put on the drawing sheet and in connection with each particular piece the statement of material, number of pieces wanted, and any special notes as to manufacture.

"This plan permits of a minimum amount of red tape, and makes it unnecessary for draftsmen to be guided by any rules other than a knowledge of mechanical drafting. There will be no cross references, no duplication, in general 100 per cent. of the time devoted to drafting and 0 per cent. to system. The above method of making drawings assumes that but few pieces are to be made alike in the shop from any one piece on the drawing and that the cost of the drawing is therefore an important percentage of the cost of the shop work."

When, however, new machines are to be built in which parts of previous machines are to be used, the above method requires these parts to be drawn over again. In addition to the extra work which this involves, there is also the defect that identical parts are treated independently in the shop, instead of being manufactured, with standard tools, jigs, etc., and so an important method of reducing cost is overlooked. Even when it has been intended to standardize certain parts, it is found that slight changes are permitted during the progress of the design, thereby throwing it out of the class of cheap manufacture. The remedy for this state of affairs is to have standard drawings for pieces which are intended for use on various machines, so that they are at once known to be standards, and not to be changed without special authority. The idea of one piece per sheet is practicable when the output of a shop is in one general line, and where no one except the assembler handles more than one or two pieces of the job, but in any case this method is not the least expensive.

Between the two methods above outlined comes another system, used by Mr. Knox with success in a works employing more than three hundred draftsmen.

"Related pieces are drawn on one sheet, and the full information as to the material of which made, pattern number, piece number, number of parts wanted, etc., is given on the drawing sheet, and while the number of sheets necessary to the manufacture of a given piece of apparatus is thus reduced to a number readily handled and kept track of, all necessity for duplicating the drawings of single pieces is avoided. This scheme is known as the 'Group System' and has certainly been found satisfactory and time saving in the concern referred to, where probably as great a variety of apparatus is manufactured, and over as wide a range of development, from the most highly standardized pieces up to the newest invention still in an experimental state, as can probably be found in any manufacturing concern in the United States."

This system has been extended to a wider scope, since the same group may be used on a number of pieces of apparatus, and a general drawing list made to take the record of information, instead of placing it on the various sheets. This drawing list, or construction specification thus becomes the master record of the system, and from the list the various sheets may be selected, the execution of these producing the required apparatus. When the workman has the drawing put into his hands he has the whole story of the pieces upon which he is working, instead of having to consult two sheets—a drawing and a specification—and is also able to see what pieces go together, thereby being able to use judgment in the degree of accuracy with which the piece is finished.

As to the advantages of the group system over that of the one piece per sheet method, much depends upon the conditions of use, each having its proper and advantageous place.

The important thing to be emphasised is the adoption and maintenance of some system in the making and use of drawings, and of recording their use and location. With this should go a historical record of changes, no change being permitted without having first been made upon the tracing, a record blue print showing the time and nature of the change being made for filing. If the change is too extensive to be made in this manner a new tracing must be made, but this should then take its place as a new drawing, and not as a revision of an old one.

Skeleton Steel Construction.

In a lecture recently delivered before the School of Architecture of the University of Pennsylvania, Mr. W. C. Furber discussed some of the features of skeleton steel building construction, with especial reference to the relation of the work of the engineer and the architect.

The incongruity of retaining forms of external arrangement when the entire principle of construction has been changed, was emphasized. Nearly all the details of architectural ornament have been evolved from the necessities of wood or stone construction, and yet these forms are repeated in terra cotta, tile, and thin veneerings of stone when all reason for their presence has departed.

"The architecture of the iron building of to-day is indefensible because it is first of all a sham, a mere pretense, purporting by its detail to be a masonry structure, yet violating every principle of masonry construction. It is ridiculous, to say the least, to see a building in which the cornices, brackets, and consoles, which are the visible evidence of the bones of the structure, and apparently support the work above them, are wired or strapped to the iron skeleton. The galvanized iron cornice and similar shams are surely no worse."

"The first and most important thing to be done, after the requirements of arrangement have been determined, is to rough out the plan and fill in the main lines of construction; for if this is done it is surprising how easily the rational development of the scheme will follow. It is well in beginning this method, to have more than one approximate plan, and they should not be determined plans. The purposes of the building and the general or specific uses to which it is to be put should have been carefully studied out, and the designer should have fixed in his mind the limitations of the problem, or in other words, he should have found out the things he cannot do. It is wonderful how it clears up the atmosphere to possibilities to discover what the impossibilities are. When you have discovered what you cannot do; the things you can do crowd themselves upon you."

Mr. Furber discusses the question of rust-protection and shows that this feature, so difficult in the case of exposed structures is comparatively simple in connection with buildings in which the structural members can be imbedded in Portland cement, this furnishing an admirable base for any acid which might otherwise produce rust. The metal work should be clean and not painted, although one coat of raw linseed oil may be applied before the members leave the works. Probably the best preparation would be sand-blasting immediately before the imbedding in concrete, this insuring an entire contact of the concrete and the metal. Closed columns should be filled with concrete before being placed in position, notwithstanding the slight delay which this may cause in erection.

"One of the greatest faults of the modern systems of fireproofing is the thinness of the covering. Any non-conducting incombustible covering will prove reasonably efficient if it is thick enough, and thoroughly secured to the columns and girders. The reason the coverings have been made so thin is this: In the transportation from materials of low resistance like stone and brick to materials of high resistance like iron and steel, the difference in the areas required for walls and piers was so great and the space saved so valuable, that the temptation has been to restrict the space occupied by the columns to the minimum. Consequently as little has been allowed for the column and girder coverings as the law allowed, and as a result a good deal of the so-called fireproof covering is insufficient and in many instances improperly applied."

The modern steel building forms a sort of intermediate structure between a bridge and a building of reinforced concrete. The former is all framed work, and usually stands out in bold and usually ugly relief, thankful if it gets its periodical coat of paint. The reinforced concrete structure has its skeleton fully covered with concrete, frequently imbedded in the form of wire netting or rods, and generally in such a form as to be impossible of exterior expression. It is there to stay, and not to be seen or indicated. In such buildings the styles and decoration which obtain with stucco on brickwork construction may be adopted with but slight inconsistency, since the external appearance does not profess to indicate to any great degree the nature of the supporting members within; columns and piers are properly constructed of concrete, with reinforcing rods within and bands about them, and structural forms originally used for masonry construction are not so inappropriate as to be condemned.

When, however, the whole building is a cage, it is almost distressing to the eye to see arches which in the natural order of things would surely force the walls asunder, did we not know that each voussoir was neatly hung upon the deep steel girder behind. The sight of innumerable stories of apparently solid masonry seemingly supported by slender pillars of terra-cotta does not inspire admiration or even respect, although we may feel assured that steel columns of ample strength are somewhere in concealment. It is this sort of thing to which Mr. Furber takes exception, and we join him most heartily in it.

In former times the architect was also the engineer, and his development of architectural styles was the natural outgrowth of the experience of artistic taste in contact with structural conditions. To-day the structural conditions are turned over to the engineer, and the architect, in too many instances, obtains his ideas from structures of other periods and methods. The result is a continual reminder of the story of the man who built his house himself, somewhat after the style of a plain box of magnified dimensions and then sent for a man to come and put some "architecture" on it. Too many of our steel structures have had "architecture" put on them in a fashion that is altogether apparent to every beholder.

The Purification of Water.

At the recent convention of the American Water Works Association, held in New York, there was presented a paper by Mr. P. A. Maignen, which reviews very clearly the progress which has been made in the purification of water for household purposes.

The earlier ideas of the purification of water were well represented by the opinions of Darcy and of Dupuit, and were based mainly upon the process of settling or sedimentation. The separation of earthy matters and other impurities, giving the water time to rest and permit the sediment to gather at the bottom of the basin, appeared to be a very simple matter. It appeared, however, that proper sedimentation required much time and very large reservoirs, and the exposure to warmth sometimes started fermentation. Some fine impurities never settled out, but were apparently disposed to remain in suspension indefinitely.

For these reasons methods of hastening sedimentation artificially were early devised, and of these the use of alum appears to have been known for a long time. Darcy goes on to say that the addition of about 5 grammes of alum per hectolitre of water, or about 2 grains per gallon was sufficient to render muddy water clear in a short time. He also spoke of the advantages of filtration, but apparently his ideas were devoted towards the object of simply rendering the water clear to the eye.

Passing by the processes which are solely chemical, as being necessary only for very hard waters, Mr. Maignen proceeds to examine the subject of water filtration as at present understood and applied in England and America.

The slow sand filter, which has been called "a heap of sand, water poured on top, and extracted from underneath," is, when properly constructed, something much more than a mere strainer. It is improperly used when it is made to receive on its surface the raw water with all its mud, and in order to get the full benefit of the filtration of the sand without the disadvantage of speedy obstruction, it is important that the heavier earthy impurities should be separated, by sedimentation or otherwise. The same is true of the so-called mechanical filter, in which the water is first dosed with a coagulant, such as alum, and then forced through the filter bed under pressure.

Mr. Maignen has devoted much attention to this question of preliminary preparation for filtration, and has devised a form of scrubber containing baffle-plates and straining devices, and finds that in this way a fairly good condition both as regards turbidity and bacterial impurities can be obtained. Such water, in cities provided with a double distribution system, as in Paris, would be plenty good enough for general purposes, etc., and would then be ready for the fuller purification necessary for portable purposes.

In filtering with the slow sand filter, the true filtering substance is the bacterial membrane (schmutzdecke) which forms on the surface of the sand after a short time, and prevents the passage of further bacterial growths. This membrane is fragile, and care must be taken that it is not disturbed or broken in any way, and when it becomes too thick the water must be drawn off and the surface scraped. Mr. Maignen proposes to deposit upon the surface of the clean sand a thin layer of asbestos fibre by mixing the fibre with the first water which goes on the filter, this forming a coating similar to felt and improving the character and rapidity of the filtration. It is claimed that with this method runs of 120 million to 180 million gallons per acre have been made between cleanings. The cleaning is effected by removing the asbestos layer and the sand is scarcely disturbed.

Regardless of the opinion which may be held as to the substitution of the layer of asbestos fibre for a portion of the thickness of the sand bed, the position as to the preliminary purification of the water before it is delivered to the sand beds is altogether reasonable, and indeed settling basins form, or should form an essential portion of a well designed filtration plant.

The best practice is to design each plant for the location and the water for which it is intended, and any attempt to decide which is the best process or construction is unadvisable before all the conditions are fully known. Water purification is now acknowledged to be a problem demanding the highest degree of skill and judgment of the engineer, and the element of judgment is especially important.

In view of the vast importance of a decision upon which may rest the health and the death rate of a community, too much care cannot be taken to arrive at a correct procedure in each case. The work is above all things of a nature to demand the attention of the highest engineering ability, and when a decision has been reached no degree of supervision and inspection can be too severe, to insure the full and complete execution of the plans which have been adopted.

A word upon the question of the relation of waste to purification may here be given. There appears at the present time in the United States to be an almost insane desire for the supply of an excessive amount of water in cities. This might be intelligible if the water so supplied could be used, or had anything to do with matters of cleanliness or health. As a matter of fact, in many American cities, more than half of the water supplied is wasted, and the magnitude of the supply demanded renders the problem of purification in some instances colossal. The extent to which political influences are interested in maintaining this delusion is in some instances but feebly concealed, and any effort to explain to the more intelligent portion of the community the great advantages of a sufficient supply of pure water, as opposed to an excessive quantity of foul water, is skilfully antagonized.

Ultimately, however, the evil must work its own remedy, and it is possible that the result may be a moderate supply of pure water together with a large supply of raw water, with double distribution; a solution which should be satisfactory both to good citizens and to politicians alike.

New York Subway Construction.

THE construction of the so-called Rapid Transit Tunnel in New York has given rise to some comparisons between the vigor and comprehensiveness of the methods there employed and those used in the construction of the London "tuppeny tube" and the Paris Metropolitain.

In London the conditions were altogether different, and the employment of the shield in boring through the stiff London clay, especially at the depth undertaken was about the only method practicable. In Paris the leisurely progress enabled one portion of the whole system to be completed when the exposition was more than half over, and the remainder will doubtless be continued in the same manner.

In New York the work has been sublet among a number of contractors, and each is using the most effective modern mechanical appliances, and of the eleven separate contracts, eight are being executed by the aid of compressed air plants, the remainder using portable steam power plants. Overhead travellers are used in such open cuttings as permit their use, and power derricks, pumps, and all practicable mechanical appliances are being driven to their utmost capacity. It is altogether probable that by the time of its completion the tunnel will have set the pace for such work at a rate only comparable with that made by the contractors on the Chicago drainage canal for that class of work, and older methods will be permanently relegated to the domain of the obsolete.

Steam Engines at the Buffalo Exposition.

In nearly all great expositions the steam power plant is one of the most important features, but at the Pan-American Exposition at Buffalo it was at first intended that steam should be made conspicuous by its absence. The power was all to be obtained from the electric current generated by the power of Niagara, and to that end arrangements were made to obtain 5,000 horse power from the Niagara plant, this being assumed to be ample.

Experience showed, however, that this amount would not be sufficient, and hence a steam "service plant" of about 3,600 h. p. was installed as an auxiliary. This service plant, however, was in no sense intended as an exhibit, and it has been made up of such material as could be obtained, and is not fairly a subject for discussion.

In addition to this there is a group of exhibits, consisting of steam engines of a number of well-known makers, and operated by boilers also forming a special exhibit, and from a recent article in *Power* we extract some points about these exhibits.

The boilers by which the steam is furnished call for no especial comment, being of the well-known Morrin Climax type, the principal feature of interest being the firing with natural gas, this enabling all dirt and ashes to be avoided, and permitting the exhibit to be as clean as any other shown.

The engines themselves, while but eleven in number, are fairly typical of excellent modern practice of their size, ranging as they do from 120 to 350 horse power, no example of the large vertical compound engine being shown.

The engines may be divided into two groups, simple and compound, there being six of the former and five of the latter. The simple engines are equally divided between the single-valve and the four-valve types, and the compound engines are two of them four-valve and three single valve.

It is an interesting evidence of the persistence of the influence of the Corliss design that all but one of the four-valve engines are of the Corliss type, differing from each other in minor details only, but the increasing use of the shaft governor of the inertia type appears, eight out of the eleven being thus regulated.

With the exception of one engine, in which the cylinder ratio was 1 to 4, the compound engines adhered to the old ratios of 1 to 2½ or 3, no attempt being made to use the larger ratios which have been so much discussed.

The general details of the various engines are fully given in the article to which reference has been made, and the principal dimensions and data tabulated in convenient form for comparison and to this the interested reader is referred. At the same time some comments may be made upon the distinctive crystallization of American engine building practice which thus appears. Leaving out of consideration the large compound units so generally accepted as the best type for direct-connected electric generators for heavy power stations, we have the single-valve automatic, and the Corliss as the two types. Extreme high-speeds have not persisted, the need for them having departed with the modifications in electric generators. The single-valve automatic, usually self-contained, with crank-shaft between bearings, and overhung cylinder, while not so economical of steam as the four-valve type, is probably as economical of money for moderate sized plants when the total outlay and depreciation charges are considered. For sizes below 100 h. p. it will probably continue to be a staple product of a limited number of establishments.

The four-valve engine, either simple or compound, will doubtless hold its own for larger powers, and the releasing valve-gear shows no signs of abandonment. The one question which has arisen in Europe concerning the Corliss valve or the flat slide valve, that of unsuitability for use with highly superheated steam, will doubtless appear in America when the growing interest in superheating begins to bear practical fruit. The lift valve, balanced and with several seats will then doubtless come into use, and the steam engine may approach more nearly to the gas engine in design.

THE ENGINEERING INDEX

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Hinged Arch.

Three-Hinged Concrete Arch Highway Bridge Over the Main at Miltenberg, Germany. Abstracted from an article by Eduard Fleischmann, in *Zeitschrift für Bauwesen*. Illustrated description; the hinges are formed of lead strips. 1400 w. Eng News—July 25, 1901. No. 42375.

Iron Bridges.

Curiosities of Early Iron Railway Bridges. Illustrated notes, made by Job Abbott, of peculiar wrought iron bridges in New Brunswick. 900 w. Eng Rec—July 27, 1901. No. 42406.

Mannheim.

The Highway Bridge over the Neckar at Mannheim (Strassenbrücke über den Neckar bei Mannheim). Carl Bernhard. A comparison of the various designs submitted in the competition for the proposed bridge. Serial, Part I. 2000 w. Zeitschr d Ver Deutscher Ing—June 15, 1901. No. 42234 D.

New South Wales.

The Proposed Sydney Harbor Bridge, Sydney, New South Wales. An account of this proposed work and the conditions under which it must be carried out, for which bids are asked by the government of New South Wales. 3800 w. Eng News—July 25, 1901. No. 42373.

The Sydney Harbor Bridge. Editorial discussion of the terms of the second competition for this structure. 1000 w. Eng Rec—July 27, 1901. No. 42401.

North Wales.

Tal y Cafn Bridge. Illustration of a bridge in North Wales, over the river Conway. Description to follow later with additional details. 100 w. Engng—July 12, 1901. No. 42335 A.

Piers.

Construction of the Cambridge Bridge Piers. Describes the methods used in replacing the old pile bridge known as the West Boston Bridge. 1800 w. Eng Rec—July 6, 1901. No. 42032.

The Dunsbach Ferry Bridge. Illustrated description of an unusual method of constructing bridge piers by means of cylinders with piles driven inside and heavy cribwork outside. 900 w. Eng Rec—July 20, 1901. No. 42174.

The Quebec Bridge Piers. Illustrated description of the large caissons and heavy masonry for the cantilever bridge over the St. Lawrence River. 2800 w. Eng Rec—July 27, 1901. No. 42402.

Plate Girder.

The Janesville Bridge. Illustrated description of a railway bridge in Wisconsin, of two 114½-foot spans of plate girders 9½ feet deep and 9 feet apart on centers. 900 w. Eng Rec—July 6, 1901. No. 42031.

Suspension.

A Factory Suspension Bridge. Describes a very light bridge of 250-ft. span, between two buildings. 1100 w. Eng Rec—July 20, 1901. No. 42176.

An Interesting Old Suspension Bridge. Description of a 450-ft. bridge over 50 years old, with cables of straight wires spliced by being flattened, and then wrapped with fine wire. 600 w. Eng Rec—July 13, 1901. No. 42123.

Viaducts.

Des Moines River Viaduct; Chicago & Northwestern Ry. Illustration of this large railway viaduct, with details of the construction and erection taken from a paper by W. C. Armstrong, in the *Iowa Engineer*. 2000 w. Eng News—June 27, 1901. No. 41887.

The Boone Viaduct. Illustrated description of the structural details of a double-track bridge 2,685 ft. long and 185 ft. in maximum height. 2500 w. Eng Rec—July 13, 1901. No. 42122.

The Chicago & Northwestern Viaduct at Boone, Ia. Illustrated description of this viaduct, which is said to be the largest double-tracked structure of its kind in the world. 1700 w. Ry Age—July 5, 1901. No. 42014.

The Mussy Viaduct (Le Viaduc de Mussy). M. Pouthier. A fully illustrated account of this fine masonry railway viaduct in the valley of the Loire, France. 10000 w. 3 plates. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42214 E + F.

CONSTRUCTION.

Building Details.

A Poor Column Seat. Illustrated description of skin work in a New York apartment house. 600 w. Eng Rec—July 27, 1901. No. 42407.

Chimneys.

See Mechanical Engineering, Steam Engineering.

Fire-proof.

Expanded Metal in Fire-Proof Construction. James S. Merritt. Describes briefly the origin of this material and the way it is made, and discusses its use in fire-proof construction. Ill. 2800 w.

Pro Engrs' Club of Phila—July, 1901. No. 42388 D.

Fire-Proof Construction in Philadelphia. Edwin F. Bertolett. Considers the developments of the past and present in the matter of rendering structures invulnerable to fire and flame. Ill. 7500 w. Pro Engrs' Club of Phila—July, 1901. No. 42387 D.

Germany.

The Public Works of Germany (Les Travaux Publics de l'Allemagne). M. de Dartein. A review of the important engineering works in progress and under discussion in Germany as shown by the exhibits at the Paris exposition. 20000 w. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42210 E + F.

Grain Elevators.

Fire-Proof Grain Elevators in America. John Kennedy. A critical comparison of the chief types, with editorial. 3800 w. Eng News—July 18, 1901. No. 42167.

Mill Construction.

A Steel Rolling Mill Building. Illustrated description of a 340 x 133-ft. steel mill building, and a 45 x 70-ft. boiler house. 1000 w. Eng Rec—July 20, 1901. No. 42177.

Reichenberg Baths.

The Emperor Francis Joseph Bath at Reichenberg. Illustrates and describes a public bath of strong construction and well equipped. 1000 w. Eng Rec—July 6, 1901. No. 42036.

Roads.

Earth Roads and Earth Work. Halbert Powers Gillette. Extract from a forthcoming book. Describes the lines along which the cross section should be designed, and discusses other important points in road construction. Ill. 4500 w. Eng News—July 25, 1901. No. 42371.

Road Building in New York State. Information concerning the progress in road construction, the material, cost, &c. Ill. 1800 w. Stone—June, 1901. No. 42180 C.

The Interior Main Road, Dominica. An illustrated account of a proposed road, already surveyed, for the improvement of the island and the opening of the interior. 2000 w. Engr, Lond—July 12, 1901. No. 42348 A.

Wear of Roads by Horse Haulage and Motor Traffic. W. Worby Beaumont. Read at Leicester meeting of the Incor. Assn. of Munic. & Co. Engrs. Also discussion. Refers principally to English roads, and considers the greatest wear due to horse's feet. 4500 w. Elec Engr, Lond—July 12, 1901. No. 42307 A.

Steel Structures.

Effects of Splicing and Riveting. George S. Morison. A statement of conclusions drawn from a study of the stresses and strains, with report of mechanical tests, and general discussion. 6600 w. Jour W Soc of Engrs—June, 1901. No. 42145 D.

Structural Details of the Manhattan Railway Power House, New York. Illustrated description of the heavy steel framing in a 100,000-H. P. power station; full details are given of the trusses and columns of the coal pockets. 2800 w. Eng Rec—July 13, 1901. No. 42125.

Stock Exchange.

The New York Stock Exchange. Percy C. Stuart. Briefly reviews the history of the N. Y. Stock Exchange, the buildings occupied, &c., and gives an account of the working out of the design for the new building, the adjustments found necessary, the engineering problems, the facilities for light, ventilation, telephoning, &c. Ill. 9800 w. Archt Rec—July, 1901. No. 42360 C.

Stone Arch.

The Revival of the Stone Arch. Reviews the effect of using iron and steel in building construction, and the causes that are tending to a revival of the stone arch, the principal one being durability. 3000 w. Engr, Lond—June 21, 1901. No. 41928 A.

Subway Construction.

Underpinning the Columbus Monument, New York. Illustrates and describes the method of supporting a 75-ft monument, weighing 724 tons, which is partly on the right of way of the New York Rapid Transit Railway. 1000 w. Eng Rec—July 27, 1901. No. 42404.

Tunnels.

The Collapse of the Pennsylvania Railroad tunnel in Baltimore. Kenneth Allen An account of the accident with discussion of the cause, and description of the work of restoration. 1300 w. Eng News—July 25, 1901. No. 42372.

The Simplon Tunnel. Reviews the progress that has been made, and considers the prospect of a completion within the time limit. 1600 w. Nature—July 4, 1901. No. 42197 A.

The Third Street Concrete and Brick-Lined Tunnel, Los Angeles, Cal. J. H. Quinton. An account of the difficulties met and the methods used in constructing this tunnel. Ill. 5700 w. Eng News—July 18, 1901. No. 42165.

Tunnel Construction on the North Bohemian Transverse Railway (Die Tunnelbauten der Nordböhmischen Transversal bahn). K. Imhof. Details of the excavating, timbering, and construction work on five short tunnels offering constructive difficulties. Three articles. 4000 w. Schweizerische Bauzeitung—June 15, 22, 29, 1901. No. 42263 each B.

CANALS, RIVERS AND HARBORS.

Austria.

Austria's Great Canal System. Outlines a recently adopted measure for a system of canals of great importance. 600 w. U S Cons Repts, No. 1085—July 12, 1901. No. 42077 D.

Canal Resistance.

Tractive Resistance of Canal Boats. Extracts from Mr. Elnathan Sweet's essay in the State Engineer's report on the proposed barge canal from the Hudson to the Great Lakes. 3500 w. Eng Rec—June 29, 1901. No. 41964.

Dams.

The Resistance of Masonry Dams (Résistance des Barrages en Maçonnerie). R. Ruffieux. An elaborate mathematical study of masonry dam construction with diagrams of profiles and pressure curves. 10000 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42213 E + F.

Dortmund.

The Dortmund-Ems Canal (Der Dort-Mund-Ems Kanal). Dr. H. Hoffmann. Especially discussing the harbor improvements at the port of Dortmund, including docks, railway terminals, etc. 3000 w. Zeitschr d Ver Deutscher Ing—July 6, 1901. No. 42239 D.

Dredge.

Petroleum Driven Dredge (Drague à Petrole). M. Wender. Describing a bucket dredge driven by a petroleum motor, and adapted for the requirements of harbour maintenance. 3500 w. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42215 E + F.

Ellis Island.

The Ellis Island Immigrant Station. Illustrated description of the buildings of this United States immigrant station in New York Harbor. 500 w. Archts & Bldrs Mag—July, 1901. No. 42043 C.

France.

The Utilisation of Canals to Revive our Seaports (Utilisation des Canaux pour le Relievement de nos Ports de Transit). A discussion of the necessity of improving the canals of France to restore the commerce of Marseilles, Havre, etc. Serial. Part I. 1200 w. Revue Technique—June 25, 1901. No. 42231 D.

Harbor Improvements.

The Harbor Works at Tampico, Mexico. Report of a lecture by E. L. Corthell, describing the twin jetties at Tampico and the improvements they have effected. 1400 w. Eng Rec—July 27, 1901. No. 42403.

Lock Gates.

Lock Gates of Wood and of Iron (Portes d'Ecluses en Fer et en Bois). M. Claise. A comparison of the two constructions with regard to repairs and cost considered in view of the magnitude of traffic. 3000 w. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42216 E + F.

Nicaragua.

The Nicaragua Canal Project and its Relation to Commercial and Industrial Prosperity. W. K. Kavanaugh, at the Industrial Convention at Philadelphia. Address urging the building of this canal by the United States. 2800 w. Pro St Louis Ry Club—July 12, 1901. No. 42390.

River Improvement.

An Official Report on the Improvement of the Chicago River. Extracts from the report of Mr. Isham Randolph. 4500 w. Eng News—June 27, 1901. No. 41886.

Improvements of the River Loire. Concerning the proposed deepening of the channel to a depth of 26 feet, and other changes. 800 w. U S Cons Repts, No. 1091—July 19, 1901. No. 42103 D.

The Regulation Works on the Rivers of Northern Germany (Régularisation des Rivières de l'Allemagne der Nord). M. Robert. A study of the river improvement work of northern Germany in view of the proposed regulation of the Loire. 12000 w. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42211 E + F.

The Thames Conservancy. A summary of the general report for the year ending Dec. 31, 1901. 2500 w. Engr, Lond—June 28, 1901. No. 42070 A.

MATERIALS.

Cement.

A New Test for the Fineness of Cement. Describes a new form of testing apparatus, known as the Goreham Flourometer, and the method of testing. 1100 w. Builder—July 20, 1901. No. 42414 A.

Engineering Problems in Cement Manufacture. S. B. Newberry. An account of the development of this industry in the United States, during the last ten or twelve years, with remarks on the nature of hydraulic materials. Ill. Also discussion. 5300 w. Jour W Soc of Engrs—June, 1901. No. 42142 D.

Portland Cements. Gives a comparison of the chemical analysis of a good Portland Cement with two natural cements of the lime and magnesia class, and discusses tests, quality, value, &c. 1200 w. Can Archt—June, 1901. No. 41969 C.

Practical Cement Testing. Gives simple ways of testing that may be used by any engineer, and shows that it is unwise to trust to a cement maker to send good cement. 3500 w. Builder—July 13, 1901. No. 42301 A.

The Cement Industry of the United States. Extracts from Mr. Bill's report concerning the rapid development of the industry, with reasons why German and Belgian cements are sold more largely than the British product. 2500 w. Arch, Lond—July 19, 1901. No. 42412 A.

The Cement Industry of Western Australia. T. A. Rickard. Outlines the general character of the deposit at Kanowna, and their formation, and gives related matter of interest. Ill. 1700 w. Eng & Min Jour—July 13, 1901. No. 42134.

The Manufacture of Portland Cement in California. Edward Booth. The effect of the discovery of petroleum in California on the industries of the state; the present article dealing with the development of the cement-making material. 1500 w. Sci Am Sup—July 13, 1901. No. 42093.

The Portland Cement Industry in California. G. P. Grimsley. Reviews the attempts made to manufacture portland cement in this state, the causes of failures, and recent plants. Ill. 1200 w. Eng & Min Jour—July 20, 1901. No. 42195.

Fireproofed Wood.

Fire Retardant Treatments of Wood. Abstract of a committee report presented at meeting of the Nat. Fire Pro. Assn. Considers chemically treated wood, and retardant coatings for wood. 2500 w. Eng News—June 27, 1901. No. 41884.

Reinforced Concrete.

A General Study of Structures in Reinforced Concrete (Considerations Générales sur les Ouvrages en Ciment Armé). J. Résal. A discussion of the principles of proportion, showing the method of obtaining the proper relations of elasticity between the metal and concrete. 6000 w. Revue Technique—June 10, 1901. No. 42228 D.

A New System of Reinforced Concrete (Ein Neues System von Armiertern Betou). B. Recordon. Describing a system of built-up construction composed of concrete beams, reinforced with imbedded metal rods. 2 articles. 2000 w. Schweizerische Bauzeitung—June 15, 22, 1901. No. 42264 each B.

Concrete—Steel Bridge and Culvert Construction on the Illinois Central R. R. Illustrations and specifications of interesting structures being carried out in connection with the extensive improvements of this railroad. 9400 w. Eng News—July 18, 1901. No. 42168.

Specifications.

Notes on Specifications for Bridge and Structural Steel. P. S. Hildreth. Notes covering some of the questions which arise in the practical carrying out of specifications. 2500 w. R R Gaz—July 19, 1901. No. 42153.

Structural Steel.

Structural Steel for Bridges, Ships and Buildings. A statement of the changes in the revised standard specifications for structural steel, recommended by a committee of the American Section of the International Assn. for Testing Materials. 600 w. Eng Rec—July 27, 1901. No. 42405.

Wood.

The Preservation of Wood (Conservation des Bois). M. H. Besson. A review of the various processes which have been used for the preservation of timber from decay, with especial reference to the Rutgers process. 7500 w. Men Soc Inglis de France—May, 1901. No. 42217 G.

MEASUREMENT.

Levelling.

A Rapid Method of Levelling. E. Philip Gilman. Short description with sketches. 700 w. B C Min Rec—July, 1901. No. 42109 B.

Surveying.

Hydrographic and Forest Surveys of the United States. Herbert M. Wilson. Explains the work of this division of the U. S. Geological Survey. Map. 2200 w. Eng News—July 11, 1901. No. 42114.

Mine Surveying Problems. W. E. Gordon. An account of methods used under peculiar conditions in the zinc-lead regions of Missouri. Ill. 900 w. Mines & Min—July, 1901. No. 42026 C.

Tape Apparatus.

Tests of the Massachusetts Institute of Technology Tape Apparatus. Alfred E. Burton and John F. Hayford. Gives a brief history of the apparatus, with an account of the tests. 2500 w. Tech Quar—June, 1901. No. 42095 E.

Thermometers.

Thermometer Glass at Higher Temperatures. William McClellan. Describes the construction of thermometers where the boiling point of mercury is raised; and gives an account of the method of testing. 2800 w. Jour Fr Inst. July, 1901. No. 42006 D.

MUNICIPAL.

Cincinnati.

Municipal Notes at Cincinnati. Concerning the bridges, sewers, streets, grade crossings, canals, &c. 2200 w. Eng News—July 11, 1901. No. 42115.

Refuse Destructors.

Refuse Destructors in Combination with Electric Power Stations. J. S. Highfield. Abstract of paper read at the Con. of Munic. Engrs. Assn. at Glasgow, with editorial comment. Considers refuse unsuitable for fuel for the generation of electrical energy. 2500 w. Elec Rev, Lond—July 19, 1901. No. 42418 A.

Roads.

See Civil Engineering, Construction.

Sewage.

Rights as to Sewage. Algernon Barker. A discussion of English law affecting sewage, citing some cases in illustration. 8700 w. Jour Roy Inst of Brit Archts—June 8, 1901. Serial. 1st part. No. 42199 B.

Sewage Disposal.

A New Septic Sewage Disposal Plant. Colin R. Wise. Illustrated description of the construction and operation of the plant at Liberty, N. Y. 2000 w. Munic Engng —July, 1901. No. 42942 C.

Sewage Disposal at Oswestry, England. Information concerning a contact-bed system. 1600 w. Eng Rec—July 6, 1901. No. 42034.

Sewage Purification.

The Bacterial Purification of Sewage (L' Epuration Bactérienne des Eaux d' Egout). G. Richou. A review of British experience in comparison with that employed on the sewage farms of Paris. 2000 w. Génie Civil—June 15, 1901. No. 42201 D.

Notes on Sewage Clarification (Beiträge zur Abwasserklärung). H. C. Nussbaum. An examination of the character of various kinds of sewage, and the purification methods applicable to each. Serial. Part I. 2000 w. Gesundheits-Ingenièur —May 31, 1901. No. 42267 B.

Sewerage.

The Sewerage System of Havana. Illustrates and describes modifications in the plans originally prepared and the introduction of novel features. 2000 w. Eng Rec—July 20, 1901. No. 42172.

Street Lighting.

See Electrical Engineering, Lighting.

Streets.

Comparison Between Asphalt and Brick Streets in Buffalo. Favoring the brick pavement. Ill. 2200 w. Brick—July, 1901. No. 41986.

WATER SUPPLY.

Artesian Wells.

A Few Remarkable Artesian Wells and the Uses to Which They Are Put. Erwin Hinckley Barbour. Illustrated account of the wells of Nebraska and South Dakota. 900 w. Sci Am—July 13, 1901. No. 42090.

Cincinnati, O.

Notes on the Construction of the New Cincinnati Water Works. Describes methods of sinking some large caissons for intake piers, pump wells and tunnel shafts, and gives description of method of constructing two reservoirs of 350,000,000 gallons capacity. 4500 w. Eng Rec—July 13, 1901. No. 42121.

Computations.

Data for Water Computations. An editorial discussion of the inadequate nature of data in several branches of hydrography. 1000 w. Eng Rec—July 20, 1901. No. 42170.

Electrolysis.

See Gas Engineering.

Filtration.

Success of Mechanical Filter at Elmira. James M. Caird. An account of the method and treatment and the gratifying results. 1500 w. Fire & Water—July 20, 1901. No. 42101.

Ground Water.

The Development of Sources of Ground-Water (Ueber die Erschliessung Unterirdischer Quellwässer). A. Tschebull. A study of the investigation of subterranean water sources, and their use for public water supply. 4500 w. Zeitsch d Oesterr Ing u Arch Ver—June 28, 1901. No. 42243 B.

Pollution.

Detecting and Preventing the Pollution of Public Water Supplies. William Watts. Read at meeting of the British Assn. of Water-Works Engrs. The remarks apply exclusively to water from moorland drainage areas. 2700 w. Builder—July 20, 1901. No. 42413 A.

Syphons.

Syphons for Water-Works. Illustrated description by Heinrich Adolf, from the *Zeitschrift d. Oest. Ing. u. Arch. Ver.*, of the principles governing the design and operation of long syphons. 2700 w. Eng Rec—July 27, 1901. No. 42408.

Water Meters.

Some Tests of Very Large Water Meters. Describes the weir used in calibrating 20 and 36-in. meters. 700 w. Eng Rec—July 13, 1901. No. 42124.

Water Rights.

A New Ruling Concerning Underground Water Rights. Review of a decision by which the New York law, making the pumping of underground water from another's land a trespass, is interpreted so as to prevent injustice to the owners of the pumping plant. 1200 w. Eng Rec—July 20, 1901. No. 42171.

MISCELLANY.

Education.

The Cultural Value of Engineering Education. F. O. Marvin. From the presidential address at the annual convention of the Society for the Promotion of Engineering Education. 2000 w. Eng News—July 4, 1901. No. 41904.

New York.

Changes and Improvements in New York. From the *N. Y. Sun.* Concerning the great engineering undertakings in progress, at a cost of many millions. 2500 w. Am Archt—July 6, 1901. No. 42004.

Review.

A Century of Civil Engineering. J. James R. Croes. Presidential address at the convention at Niagara Falls, N. Y., June 25, 1901. 7000 w. Am Soc of Civ Engrs, No. 897—June, 1901. No. 41900 E.

ECONOMICS AND INDUSTRY

Cost Keeping.

The Principles of Cost Accounting. F. A. Halsey. Lecture before the mechanical engineering students of Cornell Univ. Discusses the objects of cost accounting, the principles involved, methods, etc. 7200 w. Am Mach—June 20 and 27, 1901. Serial. 2 parts. No. 42040.

The Proper Distribution of Establishment Charges. A. Hamilton Church. A comparison of the various methods of apportioning expense to work, showing the dependence of the method to the character of the work. 4000 w. Engineering Magazine—Aug., 1901. No. 42293 B.

Education.

To What Extent and in What Direction Is It Desirable for a Professor of Engineering to Accept Engineering Employment. Prof. C. Frank Allen. Read at the Buffalo meeting of the Soc. for the Promotion of Engng. Education. 2700 w. R. R. Gaz—July 19, 1901. No. 42152.

Workshop Training for Young Engineers. R. D. Summerfield. Thinks workshops for technical schools harmful, and that they can never give the training obtained in practical workshops. 1800 w. Elec Engr, Lond—July 19, 1901. No. 42415 A.

Exhibitions.

The Glasgow International Exhibition. General review of the site, buildings, etc., and illustrated account of the exhibits in minerals, iron, steel and engineering, in its various branches. 23600 w. Ir and Coal Trds Rev—June 28, 1901. No. 42075 A.

The Pan-American Exposition. Illustrated notes on the exposition and the engineering exhibits. 8700 w. Mach, N. Y. —July, 1901. No. 41955.

Export Duty.

The Export Duty on Coal. A report of the discussion of the subject in the House of Commons, of the duty of 1s. per ton on coal exported from Great Britain or Ireland. 8000 w. Col Guard—June 28, 1901. No. 42068 A.

Franchises.

The Franchises of Telephone and Telegraph Companies, Legislative, Municipal and Congressional. G. C. Hamilton. From the *American Law Register*. Considers questions bearing on the granting of franchises. 2800 w. Elec Rev, N. Y.—July 20, 1901. No. 42186.

Glasgow Industries.

Notes on Glasgow Industries. Authoritative notes on the principal industries carried on in Glasgow and its neighborhood. Ill. 10700 w. Ir & Coal Trds Rev—June 28, 1901. No. 42076 A.

Gold Supplies.

The Influence of the New Supplies of Gold. George E. Roberts. Discusses the recent enormous increase in production and the problems arising from it. 4000 w. N Am Rev—Aug. 1901. No. 42353 D.

Japan.

Trade and Industry in Japan. Information relating to the engineering industries, their progress and development. 3000 w. Engng—June 21, 1901. No. 41918 A.

Patents.

An Improved Mode of Procedure for the Grant of Letters Patent. G. G. M. Hardingham. Discusses the present system in England and the evils arising from it, proposing a modification. 5500 w. Engng—July 19, 1901. No. 42397 A.

Statistics.

The Home and Foreign Iron and Steel Industries. Concerning the imports and exports of iron, steel and machinery. 4800 w. Ir and Coal Trds Rev—July 12, 1901. No. 42350 A.

Trade Unions.

How Trade Unionism Affects British Industries. Benjamin Taylor. Showing the social and industrial harm due to trade unions; how they restrict output and enhance the cost of production. 7000 w. N Am Rev—Aug., 1901. No. 42352 D.

Trusts.

The German Coal and Iron "Rings." Editorial discussion of the effect of these "syndicates" on trade. 1800 w. Engng—July 19, 1901. No. 42396 A.

Works Management.

A Practical View of Machine Shop Conditions in the United States. M. Cokely. A study of the relations between employer and employee, showing that the true solution of the problem lies in cheap production. 3000 w. Engineering Magazine—Aug., 1901. No. 42289 B.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable.

The Placing of a New Telephone Cable in the St. Gothard Tunnel (Verlegung-eines Neuen Kabels für den Oeffentlichen Femsprech verpelir in Gothard-tunnel). A. Baechtold. With section of the cable and a description of the method of placing. 18000 w. Elektrotech Zeitschr—June 27, 1901. No. 42281 B.

Electrical Waves.

See Electrical Engineering, Electro-Physics.

Flame Telephony.

See Electrical Engineering, Electro-Physics.

Machine Telegraphy.

The Slight Use of Automatic or Machine Telegraphy. Edward A. Calahan. Reviews the telegraphs of this class, discussing the systems, and reasons for their slow adoption, and the effect of the growing use of the telephone. 2000 w. Elec Wld & Engr—July 27, 1901. No. 42432.

Space Telegraphy.

Wireless Telegraphy Up to Date. Fernand Poncelot. An account of experiments between Brussels, Malines and Antwerp (January to March, 1901), especially dealing with the work of M. Guarini, but reviewing the work of others in this field. Ill. 2800 w. Elec Engr, Lond—July 12, 1901. Serial. 1st part. No. 42306 A.

Telegraphy.

The Importance in Telegraphy of Apparently Little Things. Thomas D. Lockwood. Full paper as read before the Assn. of Ry. Tel. Supts. at Buffalo, N. Y. Points in connection with lines, batteries and instruments are discussed. 3700 w. Pro. St. Louis Ry Club—July 12, 1901. No. 42380.

The Mercedier Telegraph. Illustrated description of a multiplex system, based upon the use of rapid oscillatory currents. 1800 w. Engng—June 28, 1901. No. 42057 A.

Telephony.

The Common-Battery Telephone System of the City of New York. Illustrates and describes an exchange equipped with the most perfect apparatus yet devised, and illustrative of the latest improvements. 1800 w. Sci Am—July 13, 1901. No. 42091.

DISTRIBUTION.

Alternating Currents.

Balancing a 3-Wire Alternating Secondary System. L. Denis. This paper was written to open a discussion on the relative merits of the different alternating current secondary systems. 1700 w. Can Elec News—July, 1901. No. 42355.

Aerial Systems.

Notes on the Construction and Protection of Aerial Transmission and Distribution Systems. K. B. Thornton. Read before the Canadian Elec. Assn. Discusses the selection and setting of poles, insulators, wires, etc. 2000 w. Elec Rev, N. Y.—July 6, 1901. No. 42016.

Current Conversion.

Conversion from Constant Alternating Potential to Constant Alternating Current. R. B. Owens. Reviews the methods principally in use, and emphasizes the advantages of a combination of impedance coils and condenser for constant potential—constant current transformation. 1200 w. Can Elec News—July, 1901. No. 42356

The Conversion of Direct into Alternating Current from the Electro-Chemical Standpoint. Showing that certain phenomena in electrolytic work can be explained by the electro-chemist. 1000 w. Elec Rev, Lond—July 19, 1901. No. 42,419 A.

Detector.

A True Ground Detector. T. W. Varley. Illustrated detailed description of the apparatus with methods of using. 2000 w. Elec Wld & Engr—July 13, 1901. No. 42130.

Direct Current.

Changing over. States the advantages of direct current over alternating, and discusses the troubles incidental to changing. 1800 w. Elec Rev, Lond—June 21, 1901. No. 41913 A.

ELECTRO-CHEMISTRY.

Accumulators.

An Alkaline Nickel-Oxide Cell. Prof. Albert L. Marsh. Remarks on experiments made by the writer, considering briefly the different oxides of nickel. 800 w. Elec Wld & Engr—July 27, 1901. No. 42434.

On Mr. Edison's New Accumulator. W. Hibbert. A discussion of some of the facts given by Dr. Kennelly in his description of the cell. 1000 w. Elec Rev, Lond—June 21, 1901. No. 41910 A.

On Theoretical Concentration Changes in the New Edison Battery. E. F. Roeber. Discusses the processes in the new Edison cell from the point of view of theory of the electrolysis of aqueous solutions. 5800 w. Elec Wld & Engr—June 29, 1901. No. 41900.

Notes on the Theory of Accumulators (Beitrag zur Theorie des Akkumulators). Dr. E. Abel. An examination of the theory of the accumulator from a thermodynamic standpoint. 1500 w. Zeitschr f Elektrochemie—June 27, 1901. No. 42,286 G.

The "Edison" Storage Cell. Briefly describes the cell and discusses its probabilities of satisfying the conditions aimed at by the inventor. 1600 w. Nature—July 4, 1901. No. 42198 A.

The Edison Storage Battery. Re-print in full of the specification of the United States patent, issued July 16. 3000 w. Elec Wld & Engr—July 27, 1901. No. 42,433.

Alloys.

Electro-Deposition of Alloys. R. A. Lehfeldt. Reviews the methods proposed for the practical preparation of alloys by electrolysis. 2400 w. Elec Chem & Met—June, 1901. No. 41905 A.

Electrochemistry.

Selected Chapters in Electrochemistry. Harry C. Jones. A series of papers on interesting and important matters in electrochemistry, first studying some phenomena on which it is founded. This first chapter considers osmotic pressure. 3300 w. Elec Rev, N. Y.—July 20, 1901. Serial. 1st part. 42184.

Electro-Deposition.

Notes on the Deposition of Copper from Various Electrolytes. A. A. Beadle. Gives results of a series of experiments conducted with the object of seeing what difference of structure copper deposited from various electrolytes under varying conditions showed from that deposited from the sulphate. 600 w. Elec Chem & Met—July, 1901. No. 42411 A.

Iron.

The Electrochemistry of Iron (Ueber die Elektrochemie des Eisens). Dr. R. Abegg. A study of the relations of iron to other metals, considered from an electrochemical viewpoint, suggesting electrochemical methods of analysis for the study of iron. 2500 w. Stahl u Eisen—July 15, 1901. No. 42257 D.

ELECTRO-PHYSICS.

Alternating Currents.

The Induced Alternating Current Discharge Studied with Reference to Its Spectrum and Especially the Ultra-Violet Spectrum. A. W. Wright and E. S. Downs. A study of this discharge when produced on a large scale, with the aim of locating observed lines and discovering their origin. 3000 w. Am Jour of Sci—July 1, 1901. No. 41941 D.

Atoms.

The Divisibility of Atoms. Edwin Edser. Discusses the subject and concludes that there is evidence that particles can be split off from atoms, and can lead an independent existence for a limited time. Electrical experiments are given. 4200 w. Elec Engr, Lond—June 28, 1901. No. 42,054 A.

Electrical Waves.

Electrical Wave-Transmission. Michael I. Pupin. Gives conclusions derived from experimental investigations, and the application to telephony and telegraphy. 900 w. Tech Quar—June, 1901. No. 42096 E.

Flame Telephony.

Sounding Flames and Flame Telephony (Tönende Flammen und Flammen-telephonie). H. T. Simon. A discussion of the singing arc and its possible applications. 4000 w. Elektrotech Zeitschr—June 20, 1901. No. 42278 B.

Hysteresis.

A Graphical Determination of the Hysteretic Angle of Advance (Graphische Ermittelung des Hysteretischen Voreilwinkels). F. Jacobson. A method by which influence of hysteresis can be simply plotted for any given case. 600 w. Elektrotech Zeitschr—June 27, 1901. No. 42,280 B.

Magnets.

The Heating of Magnet Coils. S. S. Neu, A. J. Levine, and O. A. Havill. An account of investigations made to determine the distribution of heat under various conditions, relation between rise of temperature and watts per sq. in. of radiating surface, etc. Ill. 2000 w. Elec Wld & Engr—July 13, 1901. No. 42131.

The Influence of the Forms of Pole Upon Magnetic Traction (Ueber den Einflus der Polform Magneten auf die Zugkrafl derselben). W. Beneke. A computation of the form of maximum magnetic traction for iron and steel. 2000 w. Elektrotech Zeitschr—July 4, 1901. No. 42284 B.

See also Electrical Engineering, Power Applications.

Resistance.

The Electrical Resistance of the Human Body. W. L. Hooper. From *Tufts Engineer*. An account of experimental investigations. 1100 w. Elec Rev, N. Y.—June 29, 1901. No. 41881.

Standard Cells.

Investigations of Standard Cells (Einige Untersuchungen über Normal Elemente). Dr. H. Rupp. Details of investigations of the Weston, Clark, cadmium, and other standard cells, made in the laboratory of the Technical High School at Stuttgart. Serial. Part 1. 2500 w. Elektrotech Zeitschr—July 4, 1901. No. 42285 B.

Tellurium.

The Thermo-magnetic and Galvanomagnetic Effects in Tellurium. Morton Githens Lloyd. Describes investigations giving qualitative results thus far obtained. 3000 w. Am Jour of Sci—July, 1901. No. 41940 D.

GENERATING STATIONS.

Areuse.

The Power Plants of the Valley of the Areuse (Les Usines de la Vallée de l'Areuse). M. Balling. An account of visits to the various hydro-electric stations on the river Areuse, above Neuchâtel, Switzerland. 10000 w. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42,212 E + F.

Costs.

The Equitable Allocation of Costs in Combined Lighting and Traction Stations. W. H. Tittensor. Read at the Glasgow Congress of the Munic. Elec. Assn. Discusses the cost of generation in a combined station. 3500 w. Elec Engr, Lond—June 28, 1901. No. 42055 A.

Dresden.

The Municipal Electric Plant at Dresden (Das Städtische Elektricitäts-Wesl-Kraftwerk zu Dresden). Walter Meng. A description of the new generating station recently erected in Dresden. Five generating sets of 1200 h. p. each are in use. 4000 w. Elektrotech Zeitschr—June 20, 1901. No. 42276 B.

Dynamos.

Design for a 400-Ampere Electroplating Dynamo. Cecil P. Poole. Illustrated description of the principal features of the machine. 1300 w. Am Electr'n—July, 1901. No. 41974.

The Design and Construction of Polyphase Dynamos (Der Aufbau und die Planmässige Herstellung der Drehstrom Dynamomaschine). O. Lasche. Especially discussing the constructive features of large generators, illustrated by examples of recent large equipments. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—July 13, 1901. No. 42240 D.

350-Kilowatt Steam Generator at the Glasgow Exhibition. Two-page plate with description. 1100 w. Engng—June 28, 1901. No. 42060 A.

Hagneck.

The Hagneck Electric Station (Das Elektrizitätswerk Hagneck). Dr. H. Rupp. A description of the plant in which more than 6000 h. p. is obtained from the Hagneck drainage canal near the Bielersee, Switzerland. 3500 w. Zeitschr d Ver Deutscher Ing—July 6, 1901. No. 42238 D.

Hydraulic Plant.

The Hydraulic Plant for the Electric Station at Wels, Austria (Wasserkraflanlage für das Elektricitätswerk Wels). R. Janesch. With illustrations of the dam, canal, and turbine house. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—June 21, 1901. No. 42242 B.

Italy.

Great Electric Power Stations of Italy. Enrico Bignami. A fully illustrated account of the great hydro-electric station at Paderno on the Adda; Lombardy. 4000 w. Engineering Magazine—Aug., 1901. No. 42292 B.

Load Factor.

The Influences of the Load Factor on the Design and Operation of a Lighting and Power System. J. R. Robertson. Discusses the means of increasing the load factor without appreciably increasing the investment and fixed charges. 8500 w. Can Elec News—July, 1901. No. 42357.

Rates.

Central Station Tariff System. Arthur Wright. Discusses the system described by Mr. Wallis in his recent paper before the Nat. Elec. Lgt. Convention. 1200 w. Elec Wld & Engr—July 13, 1901. No. 42133.

Short Circuiting.

The Theory of Short Circuited Electric Alternators (Zur Theorie des Kurzgeschlossen Wechselstrom-Generators). F. Horschitz. An analytical and graphical investigation of armature reaction in short-circuited alternators. 2000 w. Elektrotech Zeitschr—July 4, 1901. No. 42282 B.

Storage Batteries.

The Storage Battery in Railway Power Station Service. Lamar Lyndon. Discusses the various applications with a view to furnishing data for determining the sizes of battery and booster necessary to cover requirements under given conditions. 4000 w. St Ry Jour—July 6, 1901. No. 42038 D.

Superintendence.

The Central Station Superintendent. J. H. Vail. A prize article discussing this subject in an able manner. 3000 w. Elec Rev, N. Y.—July 13, 1901. No. 42136.

Transformers.

The Reactance Drop and Reactance Factor of Transformers. A. E. Kennelly. Develops formula and gives table prepared from it, with explanation. 1400 w. Elec Wld & Engr—July 20, 1901. No. 42140.

Vienna.

The Heiligenstadt Power House of the Vienna Municipal Railway (Das Krafthaus der Wiener Stadtbahn in Heiligenstadt). C. Budil. Illustrated description of this recent plant, with details of the 600 h. p. generating sets. 2500 w. 2 plates. Zeitschr d Ver Deutscher Ing—June 15, 1901. No. 42233 D.

LIGHTING.

Exposition Lighting.

Ground Lighting at the Pan-American and Prior Expositions. Luther Stieringer. Illustrated review of the writer's work, discussing the difficulties and defects. 2500 w. Elec Wld & Engr—July 20, 1901. No. 42148.

Incandescence.

Incandescent Lamp Economy. Abstract of a paper by Guy V. Williams, read at the Sheboygan Convention of the Northwestern Elec. Assn. on the importance of each company possessing a lamp-testing outfit and the value of the photometer when properly used. 1800 w. Elec Wld & Engr—July 6, 1901. No. 42086.

Municipal Plant.

Luton Electricity Works. Illustrated description and brief history of this municipally owned electric lighting plant in England. 1600 w. Elec Engr, Lond—July 12, 1901. No. 42305 A.

Street Lighting.

Street Electric Lighting. Bailie W. Maclay. Read before the Incor. Munic. Elec. Assn. Also discussion on the superiority of electric lighting for this purpose. 3300 w. Lightning—July 4, 1901. No. 42308 A.

Street Lighting. Discusses briefly the principal methods of arc lighting. 1800 w. Elec Rev, Lond—June 21, 1901. No. 41,914 A.

Therapeutics.

The Treatment of Lupus by the Arc Light. An illustrated article explaining treatment which has met with marked success. 2300 w. Elec Rev, Lond—July 12, 1901. No. 42316 A.

MEASUREMENTS.

Galvanometer.

Investigations on the d' Arsonval Galvanometer (Untersuchungen über d'Arsonval-Galvanometer). G. Kümmell. A comparison of galvanometers of various makers, showing methods of calibration. 1800 w. Zeitschr f Elektrochemie—July 4. 1901. No. 42287 G.

Meters.

Notes on Meter Testing. Arthur T. Smith. A few notes on the testing of an integrating wattmeter. 800 w. Elec Rev, Lond—June 21, 1901. No. 41911 A.

Power Measurement.

Power Measurement in the Case of Polyphase Circuits. J. A. Fleming. From a forthcoming book. Describes the methods of estimating in various cases giving a graphical method of solution accurate enough for practical purposes. 1700 w. Electr'n, Lond—July 5, 1901. No. 42313 A.

Motor Power Calculations. J. Boisselot. Gives rules for calculating the approximate horse power of gasoline motors. 500 w. Horseless Age—July 10, 1901. No. 42,079.

Pyrometers.

Electric Pyrometers. W. Rosenhain. Discusses the subject of the accurate measurement of high temperatures, and gives an illustrated description of some of the Griffith-Callendar instruments. 2,500 w. Elec-Chem & Met—June, 1901. Serial. 1st part. No. 41906 A.

Recording Apparatus.

An Apparatus for Recording Alternating-Current Waves. Frank A. Laws. Illustrated description of an apparatus constructed at the Rogers' Laboratory; a modification of the "contact method," by which the record is rendered continuous and traced photographically. 800 w. Tech Quar—June, 1901. No. 42097 E.

Standards.

Dominion Electrical Standards. O. Higman. Describes the apparatus procured as standards of electrical measure. 4500 w. Can Elec News—July, 1901. No. 42354.

Standards for the Testing of Electric Machinery (Normalien zur Prüfung von Elektrischen Maschinen). The full text of the proposed code to be acted upon by the German Electrotechnical Society. 4000 w. Elektrotech Zeitschr—June 13, 1901. No. 42274 B.

Explanations of the Standards for Testing Electrical Machinery (Erläuterungen Zuden Normalien zur Prüfung von Elektrischen Maschinen). G. Dettmar. Very full explanatory comments on the proposed standards of the German Electrotechnical Society. 9000 w. Elektrotech Zeitschr—June 20, 1901. No. 42277 B.

Voltameter.

A New Solution for the Copper Voltameter. William K. Shepard. Gives a solution used by the writer, and the good results obtained. 2100 w. Am Jour of Sci—July, 1901. No. 41939 D.

POWER APPLICATIONS.

Building Equipment.

A Study in Electro-Hydraulics. Frank A. Pattison. On the application of the electric motor to pumping, elevator service, fire-fighting in high buildings, etc. Ill. 2200 w. Eng News—July 4, 1901. No. 41991.

Elevators.

Test of Sprague-Pratt Elevators in the Park Row Building, New York. Gives the results of test made, and the general conditions. 2000 w. Eng Rec—July 6, 1901. No. 42033.

Factory Plant.

Power Plant in the Factory of John Mehl, Jersey City. An illustrated description of a carefully planned small plant. 1400 w. Engr, U. S. A.—July 1, 1901. No. 41987.

The New Power Plant of the Joseph Dixon Crucible Company. Illustrated description of a plant for electrically operating machinery in a number of buildings. 1300 w. Eng Rec—July 20, 1901. No. 42175.

Hoists.

Electric Hoists on the Comstock. Leon M. Hall. Describes the system installed at this mining plant. A continuous rope electric hoist, driven by means of a variable speed, three phase induction motor. 1200 w. Sci Am—July 27, 1901. No 42.-367.

Magnets.

Electro-Magnets for Heavy Lifting. George E. Walsh. On their use and economy in shops, their design, present stage of development, etc. 1800 w. Elec Rev, N. Y.—July 13, 1901. No. 42137.

Motor Efficiency.

The Efficiency Curve of a Shunt Motor and Its Relation to Operating Characteristics and the Cost of Operation. Summary of a paper by Prof. Budd Fronkenfeld, at the Sheboygan convention of the Northwestern Elec. Assn. An outline of the method of testing for efficiency. 3300 w. Elec. Wld & Engr—July 6, 1901. No. 42085.

Motors.

Use and Care of Motors. Lloyd Marshall. Some points bearing on the service and control of motors and the care needed. 1800 w. Engr, U. S. A.—July 1, 1901. No. 41988.

Newspaper Plant.

The Electrical Plant of a Philadelphia Newspaper. J. H. Vail. Illustrated detailed description of the plant of the *North American*, the oldest newspaper in America. 3000 w. Elec Wld & Engr—July 27, 1901. No. 42431.

Paper Making.

Paper Making by Electricity at Millinocket, Maine. Alton D. Adams. Illustrated description of the electric plant of the Great Northern Paper Company. 3500 w. Elec Wld & Engr—June 29, 1901. No. 41898

Polyphase Motors.

The Measurement of Energy in Polyphase Motors (Ueber Energiemessung an Drehstrommotoren). Dr. G. Stern. A discussion of the methods employed in the testing rooms of the Union Electric Company at Berlin. 3500 w. Elektrotech Zeitschr—July 4, 1901. No. 42283 B.

Power Measurement.

See Electrical Engineering, Measurement.

Power Transmission.

The Transmission of Power by Electricity (Le Transport de la Force par l'Electricité). A review of the development of the electrical transmission of power, with especial relation to the requirements in case of the introduction of electric driving on main line railways. 2000 w. Revue Technique—June 25, 1901. No. 42232 D.

Pumping.

Electrically Driven Pumping Machinery (Elektrisch Betriebene Wasserhaltungen). H. Hoffman. Especially discussing the application of electric driving to underground pumping machinery. 2500 w. Zeitschr d Ver Deutscher Ing—June 29, 1901. No. 42237 D.

The Bergmans Pump (Die Bergmanspumpe). R. Goetze. Description of an improved form of mining plunger pump, especially adapted for electric driving. 1200 w. Glückauf—July 6, 1901. No. 42270 B.

The Bergmans Electric Mine Pump. R. Goetze, in *Glückauf*. Illustrated description of a pump growing in favor in Germany. 1200 w. Col Guard—July 12, 1901. No. 42334 A.

TRANSMISSION.

Long Distance.

Western Practice in Long Distance Transmission. Begins a general review of western practice and a comparison of methods in different plants. Also editorial. 3800 w. Elec Wld & Engr—July 13, 1901. Serial. 1st part. No. 42132.

Long Span.

The Great Carquinez Transmission Span. An illustrated description of this engineering achievement at Carquinez, in California, and its construction. 4000 w. Jour of Elec—May, 1901. No. 41882.

Overhead Construction.

Notes on the Construction and Protection of Aerial Transmission and Distribution Systems. K. B. Thornton. Discusses the essential features of good construction. Ill. 4000 w. Can Elec News—July, 1901. No. 42358.

Three Phase.

Missouri River Power Company's 50,-000 Volt Transmission Plant. Illustrates and describes a 70-mile three-phase line being built in the Rocky Mountain district from Canon Ferry to Butte, Montana. 500

w. Elec Wld & Engr—July 13, 1901. No. 42129.

MISCELLANY.

Depreciation.

Depreciation of Lighting and Telephone Plants. Abstract of a paper by George Wilkinson touching many points of interest relating to the wear and tear upon plant, putting the depreciation at about 10 per cent per annum. 1600 w. Elec Wld & Engr—July 27, 1901. No. 42435.

Exposition.

Electric Machinery at the Glasgow Exhibition. Illustrates and describes interesting exhibits. 1400 w. Engr. Lond—July 12, 1901. Serial. 1st part. No. 42342 A.

Germany.

Direct Current Engineering Practice in Germany. Charles Brandeis. An illustrated description of German engineering practice and methods. 1200 w. Elec Wld & Engr—July 6, 1901. No. 42083.

GAS ENGINEERING

Accounts.

Prepayment Meter Accounts and Records. Ernest William Bell. Gives a method which has proved successful in a department operating over 5000 meters. Discussion. 3200 w. Pro Age—July 1, 1901. No. 41961.

Acetylene.

Acetylene Stoves and Their Application. A. J. Murdock. Description of a heating burner for use with acetylene gas. 1500 w. Met Work—July 6, 1901. No. 41985.

Results of Practical Experiments with High-Pressure Acetylene Lighting. Harvey T. Hauer. Read before the International Acetylene Assn., at Buffalo. On the properties and the success in lighting railway coaches, harbor and buoy lighting, and other uses, giving interesting tests made. 4000 w. Pro Age—July 15, 1901. No. 42141.

Simple Generation of Acetylene and Its Purity. Describes the Husson plant. 1500 w. Jour Gas Lgt—July 2, 1901. No. 42,106 A.

The First Acetylene Gas Works in the Netherlands (De Eerste Acetyleen-centrale in Nederland). J. A. De La Porte. Illustrated description of the plant recently erected near Duurstede, Holland. 1500 w. De Ingenieur—June 15, 1901. No. 42245 D.

The Future of Acetylene Lighting. George Landis Wilson. A copyrighted paper read before the meeting of the International Acetylene Assn., at Buffalo, N. Y. Discusses its advantages, uses and the outlook. 3800 w. Met Work—June 29, 1901. No. 41876.

Comparisons.

Comparison of Different Heating and Lighting Gases. Abstract of article, by Joh. Korting, published in the *Jour. für Gasbeleuchtung*, giving comparison and conclusions. 2700 w. Gas Wld—July 6, 1901. No. 42304 A.

Electrolysis.

The Question of Electrolysis. The evidence and discussion before the Select Committee of the House of Commons. 6400 w. Gas Wld—June 29, 1901. No. 42053 A.

Enrichment.

Enrichment of Gas by Benzol. M. A. Lecomte. Describes the apparatus of the Societe des Huiles Minerals de Colombes, giving comparisons of cannel and benzol and other information of interest. Ill. 3200 w. Gas Wld—July 20, 1901. No. 42421 A.

Heating Power and Welsbach Value of Enriched Gas. M. Verdier. Data from tests made; the heating values were ascertained with Mahler's bomb and Junkers' calorimeter, which gave concordant results. 1400 w. Gas Wld—July 20, 1901. No. 42422 A.

On the Automatic Carburation of Gas by Benzol. M. Laeaze. Brief illustrated description of method of automatically supplying the amount of benzol needed. 500 w. Gas Wld—July 20, 1901. No. 42423 A.

Fittings.

Gas and Gas Fittings. This introductory article reviews briefly the history of the gas industry. 2100 w. Builder—July 6, 1901. Serial. 1st part. No. 42300 A.

Gasholders.

A Large Gasholder for Newcastle. Detailed description and drawings. 2400 w. Jour Gas Lgt—July 2, 1901. Serial. 1st part. No. 42107 A.

Lighthouses.

Gas for Lighthouses. Editorial review of a book by Thomas Williams, on "The Life of Sir Thomas Nicholass Douglass, giving additional facts in regard to the trials of gas as an illuminan. 4000 w. Jour Gas Lgt—July 9, 1901. No. 42309 A.

Power Gas.

Power-Gas Driving with Alpine Lignite (Kraftgasbetrieb mit Alpiner Braunkohle). F. Zeyringer. Giving analyses of the Leoben, Köflach, and Fohnsdorf lignites, showing their suitability for making producer gas for gas engines. 2000 w.

Stahl u Eisen—June 15, 1901. No. 42,253 D.

The Direct Utilisation of Blast Furnace Gas (Utilisation les Gaz des Hauts Fourneaux). A Dutreux. A very full review of the progress which has been made in the direct use of waste furnace gases in internal combustion motors. From articles. 7500 w. Géne Civil—June 22, 29, July 6, 13, 1901. No. 42203 each D.

The Purification of Blast-Furnace Gases (Die Reinigung der Hochofengase). F. W. Lürmann. A response to comments upon the author's recent paper on the same subject, with additional data as to the preparation of furnace gases for use in internal-combustion motors. 1800 w. Stahl u Eisen—June 15, 1901. No. 42252 D.

The Purification of Blast Furnace Gases (L'Epuration des Gaz de Haut-Fourneau). Jules Deschamps. An examination of the impurities found in blast furnace gases, and a discussion of the methods for preparing the gas for use in internal combustion motors. Serial. Part I. 5000 w. Revue de Mécanique—June 30, 1901. No. 42220 E + F.

Utilization of Blast-Furnace Gases for the Production of Power. Summary of a paper by Herr Lürmann read at a meeting of the German Iron Works Assn., and published in *Stahl und Eisen*. Considers the purification, utilization, and appliances. 7200 w. Engr, Lond—July 5 and 12, 1901. 2 parts. No. 42328 each A.

Purification.

Purification and Method of Working Purifiers. B. W. Smith. Discusses the merits of various methods. 4000 w. Gas Engs' Mag—June 10, 1901. No. 41895 A.

Pyrogas.

Production of Lighting Gas from Smoke. A description of the process of Tobiansky d' Altoff, by which smoke and chimney gases are carburetted, and the product used for heating and lighting. 1400 w. Jour Gas Lgt—July 9, 1901. No. 42310 A.

Rates.

Differential Rates for Gas. Herr von Oechelhaeuser. Read at Vienna meeting of the German Assn. of Gas and Water Engrs. The writer's views based on extensive experience and observation, with discussion of the conditions and reasons. Diagrams. 3300 w. Jour Gas Lgt—July 16, 1901. Serial. 1st part. No. 42312 A.

Siphon.

Submerged Inverted Siphon of the Massachusetts Pipe Line Gas Co., at Everett, Mass. W. W. Cummings. Illustrates and describes this siphon, whose characteristics were its economy and rigidity for a rather unusual length. 600 w. Eng News—July 18, 1901. No. 42100.

MARINE AND NAVAL ENGINEERING

Auxiliaries.

Mercantile Auxiliaries. Lord Brassey. Read before the Inst. of Naval Archts. Reviews the history of the question and discusses the steps practicable in furtherance of a more vigorous policy. 3500 w. Engng—June 28, 1901. No. 42063 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

Bulkhead Doors.

Hydraulically-Operated Bulkhead Doors. Illustrations and explanations of method of operating the mechanism. 600 w. Engng—July 12, 1901. No. 42337 A.

Coast Defense.

Submarine Mines. Illustrated description of this means of coast defense. 1300 w. Sci Am Sup—July 27, 1901. No. 42,370.

Cost.

The Cost of Ships. Theodore Lucas. Discusses points affecting the first cost of ships. 1400 w. Naut Gaz—July 11, 1901. No. 42135.

Cruiser.

H. M. Cruiser Leviathan. Illustration and brief description. 1000 w. Engr, Lond—July 12, 1901. No. 42347 A.

Draftsmen.

Rules Governing the Employment of Draftsmen by the U. S. Navy Department. Nearly a full reprint of the recently issued order. 4500 w. Eng News—July 11, 1901. No. 42113.

Floating Dock.

Floating Dock for the Spanish Government. Illustrates and describes the largest dock afloat, just completed. It is a self-docking, pontoon dock, to be located at Port Mahon, Minorca, but was formerly intended for the Philippines. 1400 w. Engr, Lond—July 5, 1901. No. 42332 A.

Freeboard.

On Freeboard. Archibald Denny. Read before the Inst. of Naval Archts. Short historical paper placing on record important facts in connection with the work with the Load Line Regulations. 1700 w. Engng—July 5, 1901. No. 42326 A.

Gunboat.

The Shallow-Draught Gunboat "Teal." Illustration, description and report of trials of this British vessel. 900 w. Engng—June 28, 1901. No. 42061 A.

Marine Engineers.

National Prospects on the Sea and the Young Marine Engineer. George W. Melville. Briefly reviews national conditions, and the American merchant marine, calling attention to the opportunities awaiting young marine engineers. 4500 w. Stevens Ind—July, 1901. No. 42428 D.

Repairs.

Conversions and Rearmament of Ships on the Effective List. Lord Brassey. Read before the Inst. of Naval Archts. Urges the re-enforcing the navy by making improvements in seaworthy ships. 1800 w. Engng—June 28, 1901. No. 42064 A.

Speed.

On the Limits of Economical Speed of Ships. E. Tennyson-D'Eyncourt. Read before the Inst. of Naval Archts. Presents some practical rules based on facts obtained from a large number of trials of ships of different forms, and a general study of the subject. 2400 w. Engng—June 28, 1901. No. 42065 A.

Steamboats.

New York Steamboats of 1851. An account of the early steamboats of the Hudson River and Long Island Sound, with reprints of articles published in the papers of that time. 3500 w. Naut Gaz—July 18 and 25, 1901. Serial. 2 parts. No. 42150.

Steamships.

The Screw Steamer "Cape Verde" (Der Schraubendampfer "Cap Verde"). Illustrated description of a fine new steamer engaged in the Hamburg-South American trade, and built at Flensburg. 3000 w. 2 plates. Zeitschr d Ver Deutscher Ing—June 29, 1901. No. 42236 D.

Strength.

The Transverse Strength of Ships. J. Bruhn. Read before the Inst. of Naval Archts. Discusses methods of estimating, considering frames, floors, deck beams, stringers, bulkheads and wide-spaced beams. 8500 w. Engng—July 5, 1901. No. 42327 A.

Torpedo-Boat.

Oil Burning Torpedo-Boat. Illustrated description of the "Pangrang," one of three vessels recently built for the Dutch Government, the notable feature is that the boilers are fitted with a supplementary oil-burning apparatus. 1000 w. Engng—June 21, 1901. No. 41923 A.

Turbine Steamer.

The "King Edward." Illustration with description of the latest Clyde passenger steamer; built for the purpose of trying the working of the Parsons' steam-turbine machinery for mercantile purposes. 1300 w. Engng—July 5, 1901. No. 42324 A.

Turbine Steamer King Edward a Success. Illustration and general information. 1200 w. Marine Rev—July 18, 1901. No. 42187.

Vibration.

A Solution of the Vibration Problem. J. H. Macalpine. Read before the Inst. of Naval Archts. Describes a special form of balanced engine, giving reasons why the author claims that it is a practical solution of the balancing problem for steamships. 4200 w. Engng—July 12, 1901. Serial. 1st part. No. 42339 A.

Warships.

Progress of Warships and Machinery Building in England. Résume of progress during the past half-year with the work for British and foreign navies. 2500 w. Engr, Lond—June 28, 1901. No. 42074 A.

Yachts.

The America Cup Race. Editorial discussion of the racing yachts to compete. 2000 w. Engr, Lond—July 12, 1901. No. 42344 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Alcohol.

The Use of Alcohol in Motors for Automobiles (L'Emploi de l' Alcool daus les Moteurs d' Automobiles). A tabulated review of the performance of 30 different kinds of vehicles using alcohol in internal combustion motors. 2500 w. Génie Civil—June 29, 1901. No. 42206 D.

European Automobiles.

Automobiles in Europe. Information relating to the roads, recent machines, accidents, associations, and special press. 2400 w. U S Cons Repts, No. 1095—July 24, 1901. No. 42164 D.

Gasoline.

Average American Gasoline Vehicle Practice. Albert L. Clough. Information collected by the author from an examination of twelve vehicles. 1700 w. Horseless Age—July 17, 1901. No. 42159.

The New Riker Gasoline Carriage. Illustrates and describes a recently completed vehicle of the French type, with tonneau body and motor placed under a steel bonnet at the front. 2000 w. Horseless Age—July 3, 1901. No. 41984.

Liverpool Trials.

Liverpool Self-Propelled Traffic Association Third Trials of Motor Vehicles for Heavy Traffic. Descriptions and illustrations of the competing vehicles with report of trials. 13700 w. Auto Jour—June, 1901. No. 41896 A.

The Liverpool Trials. Henri G. Chatain. Describes the conditions under which these trials are held, the purposes for which the vehicles are supposed to be used, their constructive details and performance. 1500 w. Horseless Age—July 10, 1901. Serial. 1st part. No. 42078.

Military Automobile.

Marconi's Wireless Telegraphy Automobile for Military Purposes. Illustrates and describes a portable installation specially adapted to military requirements. 800 w. Sci Am—July 20, 1901. No. 42158.

Motor Cars.

Electric Motor Cars and Tests. Rankin Kennedy. Considers the tests usually made of little value, and suggests methods of testing the battery. 1200 w. Elec Rev, Lond—July 19, 1901. No. 42420 A.

Motor Trials.

Glasgow International Exhibition 500-Miles Trials. An account of the trials to take place from Sept. 2 to 6, the rules, regulations, &c. 6000 w. Auto Jour—July, 1901. No. 42361 A.

Mountain Tour.

The Passage of the St. Gothard in an Automobile. (Le Passage du Saint-Gothard en Voiturette Automobile). I. Arraou. An account of a trip of nearly 2000 miles from France to Italy and return, in a de Dion-Bouton carriage. 2000 w. Génie Civil—June 15, 1901. No. 42202 D.

Mowing Machine.

Moto-Driven Mowing Machine. Illustrated description of a design built in Chicago. 700 w. Engng—June 21, 1901. No. 41921 A.

Oil Engines.

Agricultural Oil Engines and Automobilism. A brief study of data published in regard to these engines, exhibited at the Cardiff Exhibition. 1600 w. Auto Jour—July, 1901. No. 42363 A.

Light Oil-Motor Cars. C. C. Longridge. A series of articles intended for owners and users of pleasure vehicles who have had little acquaintance with the subject before purchasing a motor car. The present article considers slow combustion oil motors and explosion motors. 1800 w. Engr, Lond—July 5, 1901. Serial. 1st part. No. 42329 A.

Paris-Berlin.

Paris-Berlin Motor Car Race. Illustrations of some of the vehicles which took part. 200 w. Engr, Lond—July 12, 1901. No. 42345 A.

Paris-Berlin Race. An account of this very successful race, with the official time of the racing vehicles. 3500 w. Auto Jour—July, 1901. No. 42362 A.

The Great Race from Paris to Berlin. Full illustrated account of this interesting race of over 744 miles. 13000 w. Auto Car. Serial. 2 parts. July 6, 13, 1901. No. 42302 each A.

The Paris-Berlin Motor Car Race. Remarks on the useful purpose served by racing, and on the performance of the vehicles in this race. 2700 w. Engr, Lond—July 19, 1901. No. 42391 A.

Paris-Bordeaux.

The Gordon-Bennett Cup and Paris-Bordeaux. An account of these events which were practically merged into one race. 2500 w. Auto Jour—June, 1901. No. 41897 A.

Voiturette.

The 6 H. P. Argyll Voiturette. Illustrated description of the construction and drive. 1500 w. Autocar—June 22, 1901. No. 41907 A.

Wheels and Tires.

Wheels and Tires for Motor Trucks. Walter L. Bodman. Discusses the problem of economical maintenance and the obtaining of ample adhesion on all kinds of roads in all kinds of weather, giving results of experiments. 2500 w. Horseless Age—July 24, 1901. No. 42359.

HYDRAULICS.

Hydraulic Plant.

See Electrical Engineering, Generating Stations.

Lift Wheel.

The Water Lift Wheels at the Maas Improvement Works (Die Schaufelräder an der Neuen Maasmündung). A description of the water lift wheels driven by compound steam engines, and used in the drainage works at the mouth of the Maas; with data of performance. 1800 w. Glaser's Annalen—July 15, 1901. No. 42262 D.

Plumbing.

Plumbing in the Prudential Buildings, Newark, N. J. Illustrated detailed description of the plumbing for four large twelve-story buildings occupying adjacent corners. 2700 w. Eng Rec—July 6, 1901. No. 42035.

Pumping.

See Electrical Engineering, Power Applications.

Tools.

Hydraulic Power in Steel-Making. R. M. Daelen. Read before the Iron and Steel Inst. Discusses the growing use of high pressures and the means of obtaining them. Ill. 2400 w. Engng—June 28, 1901. No. 42062 A.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball Bearings (Kugellager). Dr. Stribeck. A study of ball bearings with especial reference to the pressure upon the balls and the reduction of friction in various constructions. 4000 w. Glaser's Ann—July 1, 1901. No. 42259 D.

Castings.

Casting a Housing for a Saw Mill. R. H. Palmer. Illustrates casting and explains method of casting. 900 w. Am Mach—July 18, 1901. No. 42162.

Thickness of Plates Encastré. George E. Barrett. Formulas for calculating the thickness of flat cast plates, such as steam chest and cylinder covers. 700 w. Am Mach—July 25, 1901. No. 42365.

Cost Keeping.

See Economics and Industry.

Crown Bolts.

A Chapter on Crown Bolts. D. P. Kellogg. Illustrated descriptions of some of the many forms of these bolts. 800 w. Loc Engng—July, 1901. No. 41944 C.

Dies.

An Improved Blanking and Piercing Die, and Two Bending Dies. William Doran. Illustrations showing how a rather intricate job in blanking, piercing and bending sheet metal may be accomplished by the use of dies which are simple and inexpensive to construct. 1800 w. Am Mach—June 27, 1901. No. 41889.

Punching and Forming Heavy Blanks in One Operation. William Doran. Illustrates and describes a die for producing blanks from heavy sheet metal, blanking and bending them to the shape required in one operation. 1200 w. Am Mach—July 11, 1901. No. 42081.

Drawing Office.

An Outline of the Drawing Office System of the General Electric Company. S. L. G. Knox. Describes a system found satisfactory in a concern employing over three hundred draftsmen and having a total of over twelve thousand men. Ill. 3000 w. Am Mach—July 25, 1901. No. 42364.

Gears.

Table of Formulas for Bevel Gears. Edward T. Elbourne. Formulas and notes. 450 w. Am Mach—July 18, 1901. No. 42161.

Indexing.

A New Method of Compound Indexing on the Universal Milling Machine. John T. Giddings. Describes a method much shorter and more saving of labor than the one in common use. 1000 w Mach, N. Y.—July, 1901. No. 41958.

Jigs.

A Jig for Accurately Drilling a Plate. Joseph V. Woodworth. Illustrated description. 400 w. Am Mach—July 18, 1901. No. 42163.

Two Drill Jigs for Odd Shaped Castings. William Doran. Illustrated description of the design and construction. 1000 w. Am Mach—July 4, 1901. No. 41979.

Machine Tools.

British Machine Tools at the Glasgow Exhibition. Illustrations and descriptions of the exhibits. 16800 w. Engr, Lond—June 28, 1901. No. 42073 A.

Measuring.

The Interferometer. H. G. Gale. Illustrated explanation of the principle of this instrument and the method of measuring very small distances and angles in terms of the wave length of light. 4000 w. Am Mach—July 11 and 18, 1901. Serial. 2 parts. No. 42080.

Patterns.

Insuring Patterns. Frederick Conlin. The object of the paper is to bring before the Am. Found. Assn. the advisability of adopting rules governing questions of insurance. 3500 w. Jour Am Found Assn —June, 1901. No. 42160.

Repetition Work.

Repetitive Shop Processes and Interchangeable Machine Parts. Barton Cruikshank. A discussion of the fundamental rules governing successful repetition work, with examples in illustrations. 3000 w. Engineering Magazine—Aug. 1901. No. 42295 B.

Screw Machine.

The Sittman Screw Machine. Illustrated detailed description of a machine embodying new and valuable features. 3800 w. Ir Age—July 11, 1901. No. 42082.

Shops.

Shops of John Long & Sons, Johnstone, Scotland. Illustrates and describes this machine-tool building establishment of Scotland. 900 w. Am Mach—July 4, 1901. No. 41976.

The Sharon Steel Company. An illustrated detailed description of extensive works. 6500 w. Ir Age—July 4, 1901. No. 41962.

Works of G. & J. Weir, Limited, Glasgow. Illustrated description of shops where modern methods are used in the manufacture of feed-pumps, feed-heaters, evaporators, &c. 6800 w. Engng—June 21, 1901. No. 41919 A.

Tools.

Some Points of Experience in Making

Twist Drills, Taps and Dies. Wolfra M. Fox. Illustrates and describes methods used by the author. 1500 w. Am Mach—July 4, 1901. No. 41978.

Tube-Forming Tools. B. J. Dougherty. Illustrates and describes a set of tools for forming taper tubes from tin or other light gage metals. 1500 w. Am Mach—July 4, 1901. No. 41977.

Turret Lathes.

Turret Lathes at the Glasgow Exhibition. Illustrates and describes two of these machines on exhibition which represent the newest designs. 1500 w. Engng—July 5, 1901. No. 42322 A.

Works Management.

See Economics and Industry.

MATERIALS OF CONSTRUCTION.

Cables.

Investigations on Hoisting Machines (Onderzoekingen met de Trekmachine). J. H. Beucker Andreae. Especially discussing the strength of wire hoisting cables, with tabulated data and results of tests. 1800 w. De Ingenieur—July 6, 1901. No. 42247 D.

Testing.

Hydrodynamometers. R. Grimshaw. Describes an instrument peculiarly adapted to measuring the torsion or rotative effect of marine shafts and the lengthwise push on them exerted by the screw which they drive. Ill. 700 w. Am Mach—July 25, 1901. No. 42365.

Wire Rope.

Wire Rope Works at Wakefield. Brief illustrated description of works and methods employed, where steel wire rope is manufactured from pig iron, all the processes being performed on the premises. 2500 w. Engr, Lond—July 12, 1901. Serial. 1st part. No. 42343 A.

POWER AND TRANSMISSION.

Belts.

Power Transmission by Belts.. Forrest R. Jones. Illustrated discussion of the different methods of making belt connections, and the advantage of a large angle of wrap and high speed, as compared with a small angle of wrap and low speed. 3500 w. Mach, N. Y.—July, 1901. Serial. 1st part. No. 41956.

Compressed Air.

Air Compressing Plant of the Never Sweat Mine of the Anaconda Copper Mining Co. at Butte, Montana. An illustrated detailed description of Ingersoll-Sergeant Corliss compressors. 1200 w. Compound Air—July, 1901. No. 42041.

New Compressed-Air Vehicles (Nouvelles Voitures à Air Comprimé). G. Boëto. Illustrating and describing the improved compressed-air tram cars introduced on the lines of the General Omnibus Company at Paris. Serial. Part I. 3000 w. 1 plate. Génie Civil—July 13, 1901. No. 42209 D.

Notes on the Selection of an Air Compressor. Gives a list of standard types, with remarks. 1800 w.. Compressed Air—July, 1901. No. 42042.

The New Air Compressors at Pribram (Die Neueren Luftcompressoren in Pribram). J. Divis. An examination of the advantages of compressed air in mining, with a review of recent practice in Bohemia. Serial, Part I. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 6, 1901. No. 42272 B.

Conveyors.

Apparatus for the Mechanical Handling of Material at Paris (Einrichtung für die Mechanische Handhabung von Erzen, Kohlen und Koks auf der Pariser Weltausstellung). Herr Frahm. A full and illustrated review of the exhibits at the Paris Exposition. Three articles, 8000 w. Stahl u Eisen—June 1, 15, July 1, 1901. No. 42250 each D.

Coal and Ash Conveying Gear. R. A. Chattock. Read before the Incor. Munic. Elec. Assn., Glasgow. Describes the conveying apparatus most in use, pointing out their advantages and defects. 3000 w. Elec Rev, Lond—July 12, 1901. No. 42 317 A.

The Mechanical Handling of Coal Ore and Pig-Iron. Illustrates and describes some of the best types of plants in use on the Continent. 4000 w. Ir & Coal Trds Rev—July 19, 1901. No. 42400 A.

Elevator.

The Otis Double Power Hydraulic Elevator. William Baxter, Jr. An illustrated description of this system, which is an arrangement to reduce the loss of energy in cases where the average loads are far below the maximum. 1900 w. Am Mach—June 27, 1901. No. 41890.

Hauling Machinery.

Hauling Heavy Machinery Through City Streets. An illustrated discussion of methods. 2000 w. Power—July, 1901. No. 41982.

Power Gas.

See Gas Engineering.

Tide Power.

Tide Mills. An account of some of these mills which successfully utilized the power of the tides, but have been superseded by later inventions or fallen into disuse. 1900 w. Engr, Lond—July 12, 1901. No. 42349 A.

Transporters.

Handling Excavated Material at Jerome Park Reservoir. An illustrated description of modern methods of handling and transporting materials, the labor-saving devices used, etc. 1000 w. Sci Am—July 6, 1901. No. 41959.

SPECIAL MOTORS.

Alcohol.

See Mechanical Engineeering, Automobilism.

Gasoline.

See Mechanical Engineering, Automobilism.

Oil Engines.

Oil-Engine Trials at Cardiff. Particulars of the oil engines to take part in the trials. 4000 w. Engng—June 21, 1901. No. 41924 A.

Oil Engine Trials at Cardiff. An account of the trials made by the Royal Agri. Soc. of Eng., showing the oil engine to have been wonderfully improved during the past few years. Ill. 3200 w. Engng—June 28, 1901. No. 42059 A.

The Royal Agricultural Society's Show. Illustrated descriptions of a number of oil engines exhibited, and one or two other machines of interest. 4400 w. Engr, Lond—July 5, 1901. No. 42330 A.

See also Mechanical Engineering, Automobilism.

STEAM ENGINEERING.

Boilers.

Babcock and Wilcox boilers at the Glasgow Exhibition. Illustrated description of both land and marine types of these water-tube boilers. 900 w. Engng—June 21, 1901. No. 41920 A.

The Constructive Development of the Dürr Boiler in the German Navy. Von Buchholtz. Translated from *Schiffbau.* Illustrated description of these water-tube boilers as used in a number of German ships. 1600 w. Engng—July 19, 1901. Serial. 1st part. No. 42395 A.

The Parker Steam Generator. Henry G. Morris. Illustrated description of a straight tube boiler with a reversed circulation. 2000 w. Pro Engrs' Club of Phila—July, 1901. No. 42383 D.

Boiler Connections.

Water-Tube Boiler Connections (Les Assemblages des Chaudières à Tubes d'Eau). C. Walckenaer. An examination of the methods of connecting tubes in various forms of water-tube boilers, with a discussion of their merits and defects. 8000 w. Revue de Mécanique—June 30, 1901. No. 42221 E + F.

Boiler Testing.

Boiler Tests with Illinois Coals. L. P. Breckenridge. A report of the results of these tests, with discussion. Ill. 7000 w. Jour W Soc of Engrs—June, 1901. No. 42144 D.

The Value of the Capacity Test in Steam Plant Operation. George K. Hooper. A comparison of tests showing that the highest fuel economy does not always produce the cheapest steam. 3000 w. Engineering Magazine—Aug., 1901. No. 42290 B.

Chimneys.

Notes on the Construction of a Factory Chimney. Wendell Hubbard. Illustrated notes on the erection of a chimney at Camden, N. J. 1200 w. Pro Engrs' Club of Phila—July, 1901. No. 42386 D.

The Construction and Dimensions of Chimneys for Boiler Plants. Abstract of article by G. Lang, in *Zeitschrift d. Ver Deutscher Ing.* Part I. gives rules for determining the height and diameter and thickness of a stack, and explains German practice concerning materials. 3600 w. Eng Rec—July 20, 1901. Serial. 1st part. No. 42173.

The Design and Construction of Factory Chimneys. Francis Schumann. Considers only brick chimneys, discussing the form and dimensions of flue, construction, stability, design, etc. Ill. and general discussion. 6500 w. Pro Engrs' Club of Phila—July, 1901. No. 42385 D.

Circulation.

Effect of Circulation on the Capacity of Fire-Box Heating Surface. Résumé of experiments under the direction of R. C. Carpenter, giving the effect of velocity of circulation on heat absorption. 700 w Eng Rec—July 20, 1901. No. 42178.

Combustion.

A Simple Method of Determining Condition of Combustion, with Suggestions on Working Furnaces. A. Bement. Explanation of a method especially suited to the requirements of regular work. Also discussion. 4000 w. Jour W Soc of Engrs —June, 1901. No. 42143 D.

Combustion and Heat. Angus Sinclair. An explanation of the natural laws that regulate combustion and the theories of heat. 1800 w. Loc Engng—July, 1901. Serial. 1st part. No. 41949 C.

Condensers.

Jet Condensers and Air Pumps (Condenseurs par Mélange et Pumpes à Air). M. J. Nadal. A general study of the various forms of steam condensers which act by the direct contact of the steam with water, as distinguished from surface condensers. Serial. Part I. 4500 w. Revue de Mécanique—June 30, 1901. No. 42219 E + F.

Draft.

Report of Comparative Tests Made With Chimney and Mechanical Blower Drafts. From the Proceedings of the Bavarian Steam Boiler Inspection Society. Describes the tests, and the plant where they were made. Ill. 3500 w. Power—July, 1901. No. 41983.

Fuel Oil.

See Mining and Metallurgy, Miscellaneous.

Gauges.

Construction, Calibration and Care of Steam Gauges. C. W. Obert. Illustrates and describes the principal types, the standards for calibrating and correcting, ways of injuring gauges, etc. 1900 w. Am Elect'n—July, 1901. No. 41972.

Governors.

Progress in the Construction of Shaft Governors (Fortschritte im Baue von Flach reglern). F. Strnad. Illustrating improved forms of disc governors, both of the centrifugal and inertia types. 3000 w. Zeitschr d Ver Deutscher Ing—July 13, 1901. No. 42241 D.

Heating.

Central Heating Plant, Ellis Island, New York. Illustrated description of the power plant and heating system in the large immigrant landing station in New York Harbor. The present article describes the main features of the plant. 3200 w. Eng Rec—July 27, 1901. Serial. 1st part. No. 42409.

The Heating of the Exposition Rotunda at Vienna (Die Heizungsanlage in der Weltausstellungs rotunde zu Wien). G. Kölz. Illustrated description of the high-pressure steam-heating plant installed in the old rotunda of the exposition of 1873, now converted into an auditorium. 2000 w. 1 plate. Gesundheits-Ingenieur—May 31, 1901. No. 42266 B.

Ventilating and Heating the Palace of the Crown Prince of Japan. Illustrated detailed description of the work. 3000 w. Dom Engng—July 15, 1901. No. 42156 C.

Test of Radiators with Superheated Steam. Extracts from paper by R. C. Carpenter, giving results of tests, showing that superheated steam is not so useful as saturated steam for heating. 1300 w. Eng Rec—July 13, 1901. No. 42128.

Pipe Coverings.

Tests of Non-Conductive Coverings for Steam Pipes. D. S. Jacobus. An account of tests made to determine the qualities of a German covering, but giving comparative results with coverings in use in the United States. Also describes apparatus used. 2700 w. Stevens Ind—July, 1901. No. 42429 D.

Piston Speed.

A Piston Speed Chart. Sanford H. Fry. A chart designed to give the piston speed corresponding to various rotative speeds in engines having strokes from 10 to 36 inches in length, with the method of working with it. 900 w. Am Mach—June 27, 1901. No. 41888.

Steam Engines.

The Selection of a Steam Engine. William D. Ennis. Considers points that should receive careful attention before purchasing. 1200 w. Am Elect'n—July, 1901. No. 41973.

Steam Jackets.

Steam Jackets and Their Influence Upon the Efficiency of the Steam Engine. Discusses the conditions under which steam jackets give economical results. 4000 w. Marine Engng—July, 1901. No. 42009 C.

Steam-Making.

On the Science of Steam-Making. John C. Parker. States what the writer considers the principal conditions involved in the evolution of a satisfactory steam generating apparatus, and means of satisfying these conditions. 3600 w. Pro Engrs' Club of Phila—July, 1901. No. 42384 D.

Steam Plant.

Development of a Steam Plant of the Fifties. Alfred H. Schlesinger. Description of a plant and the additions made to the original installation, which gives results in efficiency about equal to those of modern construction. 1000 w. Stevens Ind—July, 1901. No. 42430 D.

Steam Turbine.

The Parson's Steam Turbine in Connection with Alternators (Parson's Stoomturbines als Eenheeden in Wisselstroom Contralen). H. F. Adams. A paper read before the Electrotechnical Section at Amsterdam, discussing mainly the Elberfeld tests. 7500 w. De Ingenieur—June 29, 1901. No. 42246 D.

MISCELLANY.

Aeronautics.

The Conquest of the Air. Brief illustrated account of the air-ship of M. Santos-Dumont, and his trip from St. Cloud around the Eiffel Tower. 500 w. Sci Am—July 27, 1901. No. 42369.

The Santos-Dumont Navigable Balloon. Description, with an account of different trials and the encouraging results. 1500 w. Autocar—July 20, 1901. No. 42381 A.

Aluminothermy.

Recent Applications of the Goldschmidt Process (Neueste Anwendungen des Goldschmidtuschen Verfahrens). Dr. Hans Goldschmidt. Describing the use of the method of producing high temperatures by the combustion of aluminum, to welding, burning castings, and to the production of Chromium and Manganese. 5000 w. Stahl u Eisen—June 1, 1901. No. 42249 D.

Bottle Machinery.

The Mechanical Manufacture of Bottles (Fabrication Mécanique des Bouteilles). A description of the Boucher machine, by which more than 80 perfect glass bottles can be made per hour. 1000 w. Génie Civil—June 29, 1901. No. 42207 D.

Bronze Powder.

The Manufacture of Bronze Powder in Germany. Information concerning this product, used for producing gilt and bronze effects in wood, paper and various metals. 1000 w. U. S. Cons Repts, No. 1087—July 15, 1901. No. 42102 D.

Building Equipment.

The Mechanical Plant of the Newark Free Public Library. Illustrates and describes a plant furnishing power, heat and light for a large library. 4200 w. Eng Rec—July 6, 1901. No. 42030.

The Power Plant of the Newark Public Library. Illustrated description of the apparatus for heating, lighting and other purposes. A correction of an error in printed plan of a former article. 1500 w. Eng Rec—July 13, 1901. No. 42126.

Education.

See Economics and Industry.

Fans.

Air Propellers. Explains the principle of the air propeller and refers to a paper by W. G. Walker describing the tests made to determine the best form of blade for propellers; also gives information on other points. 2800 w. Prac Engr—June 21, 1901. Serial. 1st part. No. 41904 A.

Guns.

Schneider-Canet Quick-Firing Guns and Howitzers for Field Service. Illustrated description of these guns and their latest improvements. 2500 w. Engng—July 19, 1901. Serial. 1st part. No. 42394 A.

The Automatic Gun and Its Military Aspects. Cecil Hamlin Taylor. Examines the general theory and practice of automatic gun construction for the purpose of indicating some of the causes of failure in the past and the probable lines of satisfactory future development. 4200 w. Jour Fr Inst—July, 1901. Serial. 1st part. No. 42005 D.

Heating.

Volume of Water in Hot-Water Heating Apparatus. Abstract of paper by W. M. Mackay, describing tests made to determine the amount of water required per square foot of radiating and heating surface. 1100 w. Eng Rec—July 13, 1901. No. 42127.

Plows.

The History of the Steel Plow. R. L. Andrey. Reviews the history and the improvements since made. 2800 w. Ir Age—July 18, 1901. No. 42147.

Pyrometers.

See Electrical Engineering, Measurement.

Refrigeration.

Trial of Refrigerating Machines at Cardiff. An illustrated description of the machine awarded the prize offered by the Royal Agricultural Soc. of Eng. 1100 w. Engng—June 28, 1901. No. 42058 A.

Typesetting.

A New Typesetting Machine. Illustrated description of a system invented by Alexander Dow. 1000 w. Sci Am—July 20, 1901. No. 42157.

Ventilation.

Ventilation. A. C. Hardy. On the importance of fresh air for the health of mankind, the support of combustion, etc., and the systems of ventilation in use. 4500 w. Dom Engng—July 15, 1901. No. 42-155 C.

Wood Screw.

Development of the Wood Screw. Charles D. Rogers. Read before the Providence, R. I., Assn. of Mech. Engrs. Interesting historical sketch. 3000 w. Ir Trd Rev—July 11, 1901. No. 42110.

MINING AND METALLURGY

COAL AND COKE.

Alabama.

The Belle Ellen Coal Mine, Alabama. William M. Given. Abstract of a paper read before the Engng. Assn. of the South. Descriptive. 1000 w. Eng & Min Jour—July 27, 1901. No. 42425.

British Resources.

Professor Geikie on Our Coal Resources. Review of an article by Prof. James Geikie, published in the *Pall Mall Magazine,* showing the need of more information in regard to the quantities of fuel in the coalfields of the British Islands. 2000 w. Jour Gas Lgt—July 16, 1901. No. 42311 A.

Coal Fields.

The Coal Fields and Seaports of the United States. Edward W. Parker. Their locations in relation to one another, the shipping routes and distances. 3000 w. Mines & Min—July, 1901. No. 42020 C.

Coal Handling.

A New Coal-Tipping Plant. J. Vaclavik, in *Oesterreichische Zeitschrift für Berg. und Hüttenwesen.* Illustrates and describes a plant based on the principle of continuous circulation on the part of the full and empty trucks. 800 w. Col Guard—July 19, 1901. No. 42398 A.

An Improved Coal Handling Plant (Eine Neuartige Kohlensturzanlage). J. Vaclavik. An improved form of overhead railway, with continuously traveling cars. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 13, 1901. No. 42273 B.

Coal Measures.

A Short Discussion of the Origin of the Coal Measures Fire Clays. T. C. Hopkins. Outlines the theory of their origin and discusses points seemingly opposed to it, giving the author's conclusions. 1700 w. Am Geol—July, 1901. No. 42179 D.

Coke.

Coke as a Substitute for Anthracite Coal. Alton D. Adams. Gives facts showing that a large plant producing coke and coal gas would be able to offer the products much lower than existing prices and that it would supply much of the demand now met by anthracite. 1100 w Sci Am—May 6, 1901. No. 41960.

Colliery Management.

The Management and Control of the Colliery. W. Blakemore. Mr. Blakemore's second paper is devoted to the surface arrangements, and to details of general management. 2500 w. Engineering Magazine—Aug., 1901. No. 42294 B.

Cuba.

On the Bituminous Deposits Situated at the South and East of Cardenas, Cuba. Herbert E. Peckham. Information concerning this field, describing a personal visit to the region, and giving the conclusions reached. 3000 w. Am Jour of Sci—July, 1901. No. 41938 D.

Explosives.

See Mining and Metallurgy, Mining.

Galicia.

The Hard Coal Deposits of Western Galicia (Die Steinkohlenablagerung Westgaliziens). F. Bartonec. A study of the geology of the region, and data concerning the output and quality of the coal. 2 articles, 3500 w. 2 plates. Oesterr Zeitschr f Berg u Hüttenwesen—June 15, 22, 1901. No. 42271 each B.

Inclined Seams.

On "The Best and Most Economical System of Working Coal Seams of a Moderate Inclination in South Wales. Ralph Hawtrey. Second Lewis Prize paper, 1900. Illustrates and describes the longwall system, discussing its advantages and applications. Also refers to the pillar and stall system. 8800 w. Ir & Coal Trds Rev—July 5, 1901. No. 42320 A.

Lignite.

Lignite Deposits, or Fields of Brown Coal in North Dakota. R. M. Haseltine. Read before the Ohio Inst. of Min. Engrs. Discusses their extent, thickness and fuel value. 3500 w. Mines & Min—July, 1901. No. 42023 C.

The Brown Coal Industry in Germany and Austria. James Stirling. From the reports issued by the Dept. of Mines of Victoria. Gives the result of personal inspection of the principal brown coal districts of the countries named. Ill. 1300 w. Col Guard—June 28, 1901. No. 42069 A.

Machine Cutting.

Coal-Cutting by Machinery in America. Introduction to a series of articles giving interesting statistics concerning the cost of production. Also editorial. 2800 w. Col Guard—July 5, 1901. Serial. 1st part. No. 42318 A.

Midland District.

Mining in the Midland District in the Nineteenth Century. A. H. Stokes. From the report of the inspector of the mines, showing the first fifty years as a period of slow development and crude methods, and the latter fifty as a period of great development and improved appliances. 6500 w. Col Guard—June 21, 1901. No. 41916 A.

New Zealand.

New Zealand Coal and Oil Company. Brief account of how the shale-works at Orepuki are to be carried on. 1500 w. N. Z. Mines Rec—June 17, 1901. No. 42382 B.

West Virginia.

Coal and Coke Developments in West Virginia. W. G. Irwin. Brief account of the flourishing condition of these industries. 1000 w. Eng & Min Jour—July 20, 1901. No. 42104.

COPPER.

Arizona.

The Copper Queen. Leslie Gillett, in the *Arizona Republican*. Describes these mines of copper-bearing iron ore, methods of mining, etc. 1700 w. Min Rept—July 18, 1901. No. 42182.

Lake Superior.

Lake Superior Copper Production. Horace J. Stevens. Reliable figures from advance returns showing the production for 1900 to be smaller than in any of the four preceding years. 2400 w. Am Mfr—July 18, 1901. No. 42100.

Mexico.

The Copper Mines of Nacosari, Mexico. Describes especially the geology of the district, and the mining conditions. 2000 w. Eng & Min Jour—July 20, 1901. No. 42192.

New Zealand.

The Copper Lode in the Ruahine Range, Near Norsewood, Hawke's Bay. W. A. McKay. Describes the location of this lode in New Zealand, its peculiarities, etc. 2200 w. N. Z. Mines Rec—May 16, 1901. No. 42047 B.

Reduction.

Reduction of Copper Ores in England

and Norway. A report of the treatment of these ores as practiced in the countries named. 1400 w. U. S. Cons Repts, No. 1080—July 6, 1901. No. 41967 D.

Reduction of Copper Ores in France. Report in answer to Department inquiries, concerning the treatment of low-grade copper ores. 4200 w. U. S. Cons Repts, No. 1081—July 8, 1901. No. 41989 D.

Reduction of Copper Ores in Germany. Information concerning the processes used. Illustrates and describes the dry process, the wet process, reduction and refining by electrolysis, &c. 4000 w. U. S. Cons Repts, No. 1079—July 5, 1901. No. 41966 D.

Reduction of Copper Ores in Mexico, Chile, Canada, and Other Countries. Brief notes describing the treatment. 1300 w. U. S. Cons Repts, No. 1084—July 11, 1901. No. 42044 D.

Reduction of Copper Ores in Spain and Austria. Report in answer to Department instruction concerning the treatment in the countries named. 2600 w. U. S. Cons Repts, No. 1082—July 9, 1901. No. 41996 D.

Smelting.

Copper Smelting in British Columbia. A. B. W. Hodges. An illustrated review of the operations of the Granby smelter and proposed improvements. 1800 w. Can Min Rev—June 30, 1901. No. 41950 B.

Smelting of Siliceous Lead-Copper Ores (Carbonates) at Llano, Sonora, Mexico. Arthur Hauman. Gives the composition of ores and fluxes, explains the peculiarities of available labor, and the methods used. 1200 w. Min & Sci Pr—July 6, 1901. No. 42088.

GOLD AND SILVER.

British Columbia.

The B. C. Mine, Summit Camp, Boundary District. S. F. Parrish. Illustrated description of this mine, yielding gold, silver and copper. 1100 w. Eng & Min Jour—July 20, 1901. No. 42189.

Dredging.

Gold Dredging Operations in California. G. P. Grimsley. Briefly reviews the industry in this State, and describes the Postelthwaite dredge and its operation. Ill. 1300 w. Eng & Min Jour—June 29, 1901. Serial. 1st part. No. 41879.

"Hole-Contract" System.

The Operation of the "Hole-Contract" System in the Center Star and War Eagle Mines, Rossland, B. C. Carl A. Davis. An advance paper to be read before the Am. Inst. of Min. Engs., with editorial. An explanation of this system, discussing its advantages, disadvantages and economic results. 3800 w. Eng & Min Jour—June 29, 1901. No. 41877.

Idaho.

Thunder Mountain, Idaho. William E. L'Hame. An account of a gold mining region which promises great richness. 1500 w. Mines & Min—July, 1901. No. 42025 C.

Klondike.

Mining on the Klondike. A. J. Bowie. Illustrates and describes the mining methods used. 7000 w. Mines & Min—July, 1901. No. 42019 C.

New Zealand.

Mining on the Thames Goldfield. Concerning the correspondence of the reefs on the east and west sides of the Moanataiari Slide. Ill. 1700 w. N. Z. Mines Rec—May 16, 1901. No. 42046 B.

Ore Treatment.

Ore Dressing and Concentration. A. W. Warwick. These terms are explained and their distinction shown, though often used synonymously. 1400 w. Min Rept—July 4, 1901. No. 42002.

Sulphide Ore Treatment. Abstract of a paper read before the Inst. of Min. & Met. An account of experimental work carried out by E. A. Ashcroft and James Swinburne during the past two and a half years. Ill. 1700 w. Elect'n, Lond—July 12, 1901. No. 42314 A.

Queensland.

Ore Treatment in Queensland. W. A. McLeod. Discusses the methods of treatment in detail, the cost, etc. 3000 w. Aust Min Stand—May 30, 1901. Serial. 1st part. No. 42052 B.

Silver-Lead.

Dry Silver-Lead Ores in the Slocan. Illustrated description of the Hewitt mine, Silverton, the ore, methods of mining, etc. 1500 w. B. C. Min Rec—July, 1901. No. 42108 B.

Silverton

The Silverton Mining District, Snohomish County, Washington. R. H. Stretch. An account of various mines in this district, which yield a variety of ores, such as galena, silver, chalcopyrite, etc. 1500 w. Eng & Min Jour—July 27, 1901. No. 42424.

Smelting.

Hot Blast Pyritic Smelting. S. E. Bretherton. Discusses what ores are suitable for pyritic smelting, and the advantages of a hot blast over a cold blast; also describing the author's apparatus. 2500 w. Ores & Met—July, 1901. No. 42099.

The Pride of the West Mill and Smelter, Washington Camp, Arizona. Jesse Scobey. Illustrated description of this property. The ore is complex carrying chalcopyrite, pyrite, zinc blende, galena, garnet, quartz, limestone and calcite. 1500 w. Eng & Min Jour—July 27, 1901. No. 42427.

Tailings.

The Canvas Table Plant of the Mitchell & Mussigbrod Mill at Garnet, Montana. Dr. Peter S. Mussigbrod. Illustrated description of the construction and operation of this table and an account of what it accomplishes. 1100 w. Eng & Min Jour—July 6, 1901. No. 42029.

Veins.

Vein-Structure at the Reynolds Mine, Georgia. G. E. Collins. Read before the Inst. of Min. & Met., in London. Illustrates and describes these gold-bearing veins. 2300 w. Eng & Min Jour—July 20, 1901. No. 42193.

IRON AND STEEL.

Iron.

See Electrical Engineering, Electrochemistry.

Manganese.

Effects of Variations in Manganese on Different Grades of Iron. Thomas D. West. Outlines the method of testing and gives results. 2000 w. Ir Trd Rev—July 11, 1901. No. 42111.

Manganese Ore in the Caucasus. Interesting particulars of the mining of this ore. 1400 w. Col Guard—June 21, 1901. No. 41917 A.

On the Manganese Ore Deposits of the Queluz (Lafayette) District, Minos Geraes Brazil. Orville A. Derby. Describes the deposits and discusses their origin, giving reasons for conclusions reached. 5400 w. Am Jour of Sci—July, 1901. No. 41937 D.

Ontario.

The Iron Ore Fields of Ontario. Willet G. Miller. A review of the iron ore deposits, giving illustrations and outline map, and showing the Province to have a great future as an ore-producing country. 7800 w. Can Min Rev—June 30, 1901. No. 41951 B.

Ore.

Iron Ore Supplies. Editorial discussion of a statement made by Mr. Schwab in his evidence before the Industrial Commission in regard to the iron ore deposits of the United States. 1800 w. Engng—July 5, 1901. No. 42325 A.

Ore Handling.

Ore Handling Machinery on the Great Lakes. James N. Hatch. A fully illustrated account of the mechanical appliances which have become such an important factor in American ascendancy in steel making. 3500 w. Engineering Magazine —Aug., 1901. No. 42288 B.

Pennsylvania.

The Cornwall Ore Hills of Pennsylvania. An illustrated historical review of this valuable iron ore property. 5500 w. Ir Age—July 18, 1901. No. 42146.

Pneumatic Feed.

Pneumatic Cone Mechanism (Pneumatischer Gichtglocken Aufzug). E. Nümker. An illustrated description of the application of a pneumatic cylinder for operating the feed cone of a blast furnace. 600 w. Stahl u Eisen—July 15, 1901. No. 42256 D.

Power Gas.

See Gas Engineering.

Statistics.

See Economics and Industry.

Steel Specifications.

Proposed Standard Specifications for Steel for Bridges, Ships, Forgings and Railway Rails. A copy of the specifications for purposes named as formulated by a committee of the International Assn. for Testing Materials. 4000 w. Eng News—July 4, 1901. No. 41993.

Steel Works.

The New Steel Works at Niederschelden on the Sieg (Die Neuen Stahlwerksaulgen zu Niederschelden a. Sieg). With photographs and plans of the new steel plant of the Charlottenhütte. 1800 w. Stahl u Eisen—July 15, 1901. No. 42-255 D.

The Works of the Dominion Iron & Steel Co. at Sydney, Cape Breton. Illustrated detailed description of this recently completed plant. 3500 w. Eng News—July 25, 1901. No. 42374.

Urals.

The Iron Industry of the Southern Urals (La Sidérurgie dans l'Oural Méridional). M. A. Gouvy. An account of the existing furnaces and a description of the riches of the region and its need of railway communication. 15000 w. 3 plates. Mem Soc Ing Civ de France—May, 1901. No. 42218 G.

The Manufacture of Pig Iron in the Southern Urals (Die Grundlagen zur Roheisenerzeugung in Südlichen Ural). A. Gouvy. With map of the region and data concerning the present manufacture. Vast beds of ore would be made available if railways were built. 2500 w. Stahl u Eisen—July 1, 1901. No. 42254 D.

Water Cooling.

A Water-Cooled Blast-Furnace Book. Axel Sahlin. Read before the Iron & Steel Inst. Illustrates and describes a device which consists of a plate shell in the shape of an inverted frustum. 1800 w. Engng —July 12, 1901. No. 42340 A.

MINING.

Austria.

Mining in Austria. H. R. Jastrow. Concerning the production of the various minerals, and interesting facts relating to the mining industry. 1000 w. Eng & Min Jour—July 27, 1901. No. 42426.

British Columbia.

The Mineral Production of British Columbia. Abstract of the report of William Fleet Robertson, the Provincial metallurgist. 3500 w. Eng & Min Jour—July 20, 1901. No. 42191.

Compressed Air.

See Mechanical Engineering, Power and Transmission.

Deposits.

Genesis of Ore Deposits. Matt. W. Alderson. Outlines conclusions reached, and maintains that all mineral deposits were formed by streams flowing on the surface of the earth at the time the deposits were made. 3000 w. Min & Sci Pr—July 6, 1901. Serial. 1st part. No. 42087.

Drainage.

Mine Drainage. On the various systems of pumping, especially emphasizing the advantages of the electric pump. Ill. 2000 w. Min Rept—July 4, 1901. No. 42003.

Explosives.

Explosives in Coal Mines. A list of explosives added to the special list of permitted explosives in British mines. 2000 w. Col Guard—June 28, 1901. No. 42066 A.

Flameless Explosives and Coal Dust. James Ashworth. An account of the explosion on April 19, in the Four-feet mine of the Walthew House Colliery, near Wigan. 2100 w. Col Guard—July 5, 1901. No. 42319 A.

The Employment of Safety Explosives in Fiery Mines. P. Chalon, in *Revue* Technique. Discusses their advantages and defects, and the practical means of testing. 2500 w. Col Guard—June 28, 1901. No. 42067 A.

The Use of Safety Explosives (Emploi des Explosifs de Surété). P. Chalon. A review of the nature and behavior of mining explosives adapted for safe use in gaseous mines. 2500 w. Revue Technique—June 10, 1901. No. 42229 D.

Fire Damp.

An Electric Fire Damp Indicator (Sur un Grisoumetre Electrique). G. Leon. The apparatus depends for its action upon the difference in electrical resistance between two platinum wires, heated by the same current, and placed, one in air, the other in the fire damp. 1200 w. Comptes Rendus—June 10, 1901. No. 42244 D.

Haulage.

Mine Locomotives. W. B. Clarke. A comparison of the efficiencies and relative cost of installations of electricity and compressed air. 2200 w. Mines & Min—July, 1901. No. 42024 C.

Self-acting Haulage in Fifeshire. Philip Hodge. Read before the British Soc. of Min. Students. Illustrates and describes systems for bringing coals from a higher to a lower level. 2700 w. Ir & Coal Trds Rev—July 19, 1901. No. 42399 A.

Life Saving.

Automatic Life-Saving Apparatus (Automatischer Sauerstoff Rettungsapparat). Dr. L. Michaelis. An illustrated description of the 1901 Model of the Giersberg apparatus, carrying compressed oxygen, and an absorbent of carbonic acid. 1500 w. 1 plate. Glückauf—June 22, 1901. No. 42669 B.

Ore Treatment.

Ore Dressing and Concentration. A. W. Warwick. Discusses the methods of separation of various kinds of ores. 1700 w. Min Rept—July 11, 1901. No. 42139.

Pumping.

See Electrical Engineering, Power Applications.

Quarrying.

Stripping. Frank W. Hoyt. Some general suggestions based upon experience. Ill. 2500 w. Quarry—July 1, 1901. No. 42094 A.

Quebec.

The Mineral Production of Quebec. From the report of J. Obalski, inspector of mines for the Province. 1400 w. Eng & Min Jour—July 20, 1901. No. 42190.

Safety Devices.

Safety Appliances at the Exposition of 1900 (Les Appareils de Securité à l'Exposition de 1900). H. Schmerber. Discussing especially the safety appliances used in connection with mining hoists, etc. Serial. Part I. 2000 w. 1 plate. Génie Civil—June 29, 1901. No. 42205 D.

Safety Lamps.

Experiments on the Penetrability of Safety Lamps (Durchblaseversuche mit Sicherheitslampen). H. Fändrich. An examination of the resistance offered by the wire gauze of safety lamps to the penetration of gases under pressure. Two articles. 7500 w. 2 plates. Glückauf—June 8 and 15, 1901. No. 42268 each B.

Shaft Sinking.

Sinking Through Swamp, Clay and Sand at Huntly, Waikald District. William Tottley. Describes the difficulties met in a New Zealand coalfield. 2200 w. N. Z. Mines Rec—May 16, 1901. No. 42-048 B.

The Application of the Freezing Method in Shaft Sinking at Limburg (De Toepassing der Bevriesmethode bij het Maken van Schachten in Limburg). J. Koster. Describing the application of the Honigmann process for sinking a shaft 320 feet deep in sand. 5000 w. De Ingenieur—July 13, 1901. No. 42248 D.

Surveying.

See Civil Engineering, Measurement.

United States.

The Mineral Production of the United States. Tables and general comments. 5800 w. Eng & Min Jour—June 29, 1901 No. 41878.

MISCELLANY.

Aluminum.

Improvement in the Metallurgy of Aluminum. Clinton Paul Townsend. Concerning the electric furnace methods for the purification of bauxite, which will probably reduce the cost of aluminum of certain grades. 1200 w. Elec Wld & Engr—July 6, 1901. No. 42084.

Bauxite.

Bauxite in New South Wales. A report of the known deposits with analysis. 350 w. U. S. Cons Repts, No. 1100—July 30, 1901. No. 42410 D.

Carnotite.

The Commercial Treatment of Carnotite. J. Ohly. Description of the chemical concentration of the values contained in this mineral. The instruction is limited to the extraction of uranium values exclusively. 2000 w. Min Rept—July 25, 1901. No. 42380.

Charcoal.

By-Products from Charcoal. Frank H. Mason. The products from various woods and how they are obtained and marketed. From the U S Cons Repts. 3500 w. Mines & Min—July, 1901. No. 42022 C.

Diamonds.

Australian Diamond Washing. Describes the care taken in the washing of diamondiferous gravels. 900 w. Min Rept—June 27, 1901. No. 41943.

Fuel Oil.

Tests of Texas and California Fuel Oils. Howard Stillman, in the *N. Y. Commercial.* Reports the tests of the Southern Pacific R. R. Co., which has used fuel oil for locomotive service for several years. 900 w. Eng News—July 11, 1901. No. 42116.

Opals.

Australian Opal and Opal Mining. John Plummer. Concerning the difficulties of prospecting, the value and points determining it. 1000 w. Min Rept—July 18, 1901. No. 42183.

Petroleum.

Origin of Petroleum. A statement of various theories which have been proposed and some of the facts in support of them. 2000 w. Mines & Min—July, 1901. No. 42021 C.

The Great Oil Well Near Beaumont, Texas. Anthony F. Lucas. Gives an account of the discovery and method of controlling the well, the hydraulic system of boring, the geology of the region and the product obtained. Ill. 4800 w. Am Mfr—July 11, 1901. No. 42104.

The Petroleum-Bearing Rocks of Poverty Bay and East Cape Districts. From the report of the government geologists, describing the district. 3700 w. N. Z. Mines Rec—May 16, 1901. No. 42045 B.

Philippines.

The Mineral Resources of the Philippines. Information concerning the minerals and other products of these islands. 2500 w. Am Mfr—July 11, 1901. No. 42105.

Pyrometers.

See Electrical Engineering, Measurement.

Spain.

Coal and Iron in Spain. Information relating to imports and exports. 1500 w. Col Guard—July 12, 1901. No. 42333 A.

Zinc.

The New Zinc Field. Waldon Fawcett. Information concerning the Missouri-Kansas district, the peculiarities, the cleaning of the ore, etc. 1300 w. Sci Am—July 13, 1901. No. 42092.

Zinc Mining in Kansas. Harry L. Wohlford. Gives the early history of this district, describes the ores, the modern methods and output. Ill. 1000 w. Sci Am—July 13, 1901. No. 42089.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in May. Detailed list and classified summary. 3700 w. R R Gaz—July 12, 1901. No. 42120.

High Speed.

The Alleged "Railway Race." Charles Rous-Marten. On misconceptions appearing in the British daily papers and how they have arisen, with a statement of facts. 2800 w. Engr, Lond—July 5, 1901. No. 42331 A.

The American Locomotive as a High-Speed Machine. E. P. Watson. A discussion of future possibilities in railway speeds, showing the track rather than the engine to be in need of improvement. 3500 w. Engineering Magazine—Aug., 1901. No. 42291 B.

St. Louis.

Street Railway Progress in St. Louis. An illustrated article dealing with present progress, past improvements, consolidations, management, etc. 5600 w. St Ry Jour—July 6, 1901. No. 42037 D.

Syracuse, N. Y.

Street Railway Evolution in Syracuse. E. G. Connette. An account of how the improved conditions in this city were brought about. 2500 w. St Ry Jour—July 6, 1901. No. 42039 D.

Train-Despatching.

Simplification of Train-Despatching. Editorial on the changes made in the time-tables of the Chicago, Burlington & Quincy R. R. 2500 w. R R Gaz—July 19, 1901. No. 42154.

FINANCIAL.

Connecticut.

Railway Interests in the Connecticut Legislature. Clarence Deming. A review of the steam-trolley conflict of the last decade. 1500 w. R R Gaz—July 19, 1901. No. 42151.

Statistics.

Statistics of Railways of the United States for the Year Ending June 30, 1901. Abstract of the report of the Inter-state Commerce Commission, giving figures of interest in regard to mileage, equipment, employees, service, earnings, accidents, etc. 1600 w. Eng News—July 18, 1901. No. 42166.

MOTIVE POWER AND EQUIPMENT.

Birmingham, Eng.

Electric Traction in Birmingham. Illustrated detailed description of the first overhead trolley system in this city, which is an example of the best construction. 1700 w. Tram & Ry Wld—June 13, 1901. No. 42049 B.

Brakes.

Braking Apparatus for Electric Cars. A. L. C. Fell. Discusses car brakes under six heads; hand, friction, slipper, pneumatic, electromagnetic, and Newell electromagnetic brakes. 1500 w. Elec Engr, Lond—June 28, 1901. No. 42056 A.

Recent Practice in Freight Train Braking. Editorial on the application of airbrakes to freight cars, the practice in making up trains where all cars are not fitted, points for improvement, etc. Eng News—July 4, 1901. No. 41992.

The Siemens Electric Control for Air-Brakes (Ueber die Elektrische Steuerung für Luftdruck bremsen). H. Wagner. A description of the electric control intended to give more rapid action than the triple valve, the apparatus is designed for use on the proposed military railway between Berlin and Süterbog. Serial, Part I. 3000 w. Glaser's Annalen—July 15, 1901. No. 42261 D.

Brake Shoes.

The Brake Shoe Tests. F. W. Sargent. Facts and theories from a study of the record of the Laboratory Tests of the M. C. B. Assn. Describes the material of the competing shoes, and their action under test. Diagrams. 3000 w. R R Gaz—July 12, 1901. No. 42118.

Cable Line.

Cabling the Edinburgh Tramways. Illustrates and describes the distinguishing features of this work now nearing completion. 3000 w. Engr, Lond—July 12, 1901. Serial, 1st part. No. 42341 A.

Cars.

80,000-lbs. Capacity Box Cars of the Atchison, Topeka, & Santa Fe. Illustrated description. 700 w. R R Gaz—July 26, 1901. No. 42377.

Forty-Ton Hopper Bottom Coal Cars, C. B. & Q. R. R. Illustrations of new cars now building which show novel features. 500 w. Ry & Engng Rev—July 13, 1901. No. 42140.

Freight Cars for the North of Spain Railroad. Brief illustrated description. 500 w. R R Gaz—June 28, 1901. No. 41893.

Increasing the Capacity of Freight Cars (Ueber die Erhöhung der Ladefähigkeit der Offener Güterwagen). H. Schwabe. A discussion of the commercial importance of large cars and automatic unloading methods, based mainly on American practice. 4000 w. Stahl u Eisen—June 1, 1901. No. 42251 D.

100,000 Pounds Capacity Steel Hopper Cars. The specially interesting features of the design given are the light weight of the car and the method of construction in which the center sills are made of light sections, reinforced by truss rods. Ill. 800 w. Am Engr & R R Jour—July, 1901. No. 41980 C.

Draft Gear.

Draft Gear. From a committee report to the Master Car Builders' Assn. at the Saratoga meeting. Considers design, materials, tests, etc. Ill. 2600 w. Ry & Engng Rev—June 29, 1901. No. 41952.

Electric Traction.

Electric Railways. Major P. Cardew First of a series of Cantor Lectures. Gives a brief historical summary of practical electric railways in Europe; discusses the advantages of electric traction, and details of operation. 9000 w. Jour Soc of Arts—July 12, 1901. Serial. 1st part. No. 42196 A.

Multiple-Unit Traction (La Traction à Unités Motrices Multiples). A description of the system of the French Thomson-

Houston Company as used on the Meudon railway, France. 1800 w. Revue Technique—June 25, 1901. No. 42230 D.

On Polyphase Generating and Sub-Station Plant for Electric Traction. H. S. Meyer. Discussing points in article by A. C. Eborall. 1800 w. Elec Rev, Lond—July 5, 1901. No. 42315 A.

European Railways.

European Railway Jottings. Charles Rous-Marten. Concerning the American engines furnished for the Midland railway, and the qualities of British and American locomotives. 2000 w. Loc Engng—July, 1901. No. 41948 C.

Fuel Consumption.

Suggested Methods for Reducing Locomotive Fuel Consumption. Abstract of a report presented to the Am. Ry. Mas. Mech.'s Assn. Considers means along which economy may be secured. Also editorial on feed-water heating for locomotives. Ill. 4300 w. Eng News—June 27, 1901. No. 41885.

Locomotives.

American Locomotives in England. A discussion of Mr. Rous-Marten's article in defense of American locomotives. 1800 w. Engr, Lond—June 28, 1901. Serial. 1st part. No. 42071 A.

A New Mogul for the New York, Ontario & Western. Illustrated description. 600 w. R R Gaz—July 26, 1901. No. 42378.

"Chautauqua" Type Passenger Locomotive; Chicago, Rock Island & Pacific Ry. Illustrations and details of a recently built engine. 700 w. Eng News—July 11, 1901. No. 42112.

Combustion in Locomotives. Letters and editorial commenting on Mr. Rous-Marten's article comparing American and British engines. 3400 w. Engr, Lond—June 21, 1901. No. 41929 A.

Dutch Locomotives. J. Janette Walen. Illustrates and describes engines used by the Dutch State Railways. 1000 w. Ry & Loc Engng—July, 1901. No. 41945 C.

Express Locomotives, South-Eastern & Chatham Railway. Gives illustrations and principal particulars of bogie express engines. 600 w. Engr, Lond—July 10, 1901. No. 42393 A.

Express Locomotive for the South-eastern and Chatham Railway; Glasgow Exhibition. Illustrated description, giving dimensions. 900 w. Engng—June 21, 1901. No. 41922 A.

Heavy Express Locomotive (Locomotive Express pour Trains Lourds). An illustrated description of the 10-wheel passenger locomotive exhibited at Paris by the North Eastern Railway. 1800 w. 1 plate. Génie Civil—June 22, 1901. No. 42204 D.

Relative Merits of British and American Locomotives. Editorial on the recent controversy over the American locomotives sold to railway companies abroad. 1300 w. Loc Engng—July, 1901. No. 41947 C.

Richmond Compound Locomotives for the Rio Grande Western. Illustrated description. 500 w. R R Gaz—June 28, 1901. No. 41892.

The High Speed Steam Locomotive (Die Dampflokomotive für Grosse Gesschwindigkeit). H. von Borries. An examination of the lines along which improvement may be expected, with a review of the study of Fränkel upon the same subject. 1000 w. Glaser's Annalen—June 15, 1901. No. 42258 D.

The Italian Locomotives at the Exposition of 1900 (Les Locomotives Italiennes á l'Exposition de 1900). F. Barbier. Illustrated description of the three engines exhibited. 2000 w. 2 plates. Rev Gen des Chem de Fer—June, 1901. No. 42226 H.

Three-Cylinder Compound Locomotive for the North-Eastern Railway. Illustrated detailed description of an engine which can be worked as a simple engine, as a semi-compound, or a compound. 2000 w. Engng—July 5, 1901. No. 42323 A.

Trials of an Italian Locomotive on a French Railway. An account of the trials of a locomotive exhibited at Paris, designed to run cab first, and the favorable results. 3000 w. Engr, Lond—July 12, 1901. No. 42346 A.

Wide Firebox Locomotive for Burning Anthracite Culm; Delaware, Lackawanna & Western R. R. Illustrated description of a passenger engine now building. 500 w. Eng News—July 25, 1901. No. 42376.

London Tramways.

Electric Tramways in London. An account of London's first electric line, the large patronage, power, &c. 2500 w. Engng—July 12, 1901. No. 42338 A.

London United Tramways. Begins an account of this great undertaking of providing constant inter-communication between London and its western suburbs. 2500 w. Elec Rev, Lond—July 19, 1901. Serial. 1st part. No. 42417 A.

The London United Electric Tramways. Illustrated description of interesting features. 1600 w. Engr, Lond—July 19, 1901. No. 42392 A.

Manchester, Eng.

Manchester Corporation Tramways. General notice of the undertaking and illustrated description of the section now open. 2900 w. Tram & Ry Wld—June 13, 1901. No. 42051 B.

Oil Fuel.

Burning Oil in Locomotives. H. M. Honn. Illustrates and describes the equipping of an engine for oil fuel, and the successful firing. 800 w. Soc Engng—July, 1901. No. 41946 C.

Power Consumption.

The Watt-Hour Consumption of Electric Railways (Berechnung des Wattstundenverbranches Elektrischer Bahnen). E. E. Volkers. The various elements of resistance are taken into account, and it is shown that an efficiency of 58 per cent. is practicable. 4500 w. Elektrotech Zeitschr—June 13, 1901. No. 42275 B.

Railway Apparatus.

The Westinghouse Electric Brake and Heater. Illustrated description of the arrangement and construction of the apparatus, the method of attaching the brake rigging to the truck, &c., with a statement of the advantages. 1200 w. R. R. Gaz—June 28, 1901. No. 41891.

Splicing Sills.

Splicing Sills in Long Passenger Equipment. From the topical discussion of the M. C. B. convention. Ill. 1000 w. Ry & Engng Rev—July 6, 1901. No. 42027.

Springs.

Revision of Recommended Practice for Springs, including Design for Springs for 100,000-Pound Cars. Committee report to the M. C. B. Assn. Ill. 1000 w. Am Engr & R R Jour—July, 1901. No. 41981 C.

Underground.

Proposed Underground Electric Railways for Buenos Ayres. L. D. Tandy. An illustrated description of this beautiful South American city, with an account of the tramway situation, and the possibilities of the proposed underground railway. 4200 w. Tram & Ry Wld—June 13, 1901. No. 42050 B.

Valteline.

The Valteline Electric Railway (Chemin de Fer Electrique de la Valteline). H. Martin. A very full description of the three-phase high pressure system, as applied to 65 miles of main-line railway. 3500 w. 1 plate. Génie Civil—June 15, 1901. No. 42200 D.

Wheels.

Cast-Iron Wheels. Committee report to the Master Car Builders' Assn. Ill. 900 w. Ry & Engng Rev—June 29, 1901. No. 41953.

NEW PROJECTS.

Africa.

Lagos Government Railway. The terminal station is located on Iddo Island, and the connection with the main land and Lagos is made by bridges. Particulars of the Carter bridge, which is over 2200-ft. in length, are given. Ill. 2200 w. Engr, Lond—June 28, 1901. No. 42072 A.

Korea.

New Korean Railway. A statement extracted from the *Japan Daily Mail*, concerning the proposed Seoul-Fusan Railway, which is now being surveyed. 1000 w. U S Cons Repts, No. 1096—July 25, 1901. No. 42351 D.

Switzerland.

The New Lines of Rhaetian Railway. (Die Neuen Linien der Rhätischen Bahn). H. Hennings. With topographical maps and profiles of the new line between Thusis and St. Moritz, and plans of the loop tunnels and other construction work. Serial, Part I. Schweizerische Bauzeitung—July 6, 1901. No. 42265 B.

PERMANENT WAY AND BUILDINGS.

Boston Elevated.

The Boston Electric Elevated Railway. Illustrated notes on the equipment of the Boston Elevated Railway Company's new lines, power stations and trains. 1500 w. Elec Rev, N. Y.—June 29, 1901. No. 41880.

Construction.

Construction on the Clinch Valley Division, Norfolk and Western R. R. Illustrated descriptions of particular portions of the work, with summary taken from Mr. Low's paper, in the *Pro. of the Am. Soc. of Civ. Engrs.* 2000 w. Ry & Engng Rev—July 20, 1901. No. 42188.

The Railway from Toul to Pont Saint-Vincent (Ligne de Toul à Pont Saint-Vincent). M. Descubes. A general description of the construction of a new branch line of the Eastern Railway of France. Serial. Part I. 7500 w. 1 plate. Rev Gen des Chem de Fer—May, 1901. No. 42222 H.

Freight Station.

Central Ave. Freight Station at Cincinnati; C. C. C. & St. L. Ry. Illustrated description of rapid construction work. 1500 w. Eng News—July 4, 1901. No. 41995.

New York Elevated.

Construction of the Manhattan Elevated Railway in New York (Bau Konstruktion der Manhattan-Hochbahn in New York). F. M. von der Werra. A fully illustrated account of the structural work on the elevated railway in New York. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—June 22, 1901. No. 42235 D.

Rapid Transit Ry.

Section Four of the New York Rapid Transit Railway. Illustrates and describes the methods of work in rock tunnel. 3500 w. Eng Rec—June 29, 1901. No. 41963.

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Terminal.

The Mechanical Plant at the Boston South Terminal (Die Stellwerkanlage des Bostoner Süd-Bahnhofes). Prof. F. Reuleaux. A detailed account of the whole plant with many illustrations. Two articles. 1 plate. 4000 w. Glaser's Annalen—July 1, 15, 1901. No. 42260 each D.

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The Albany and Hudson Railroad. An illustrated article giving operative details of the largest third-rail electric railway system in the world. 2500 w. Elec Rev, N. Y.—July 20, 1901. No. 42185.

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Permanent Way for Electric Tramways. W. Howard-Smith. Read at Leicester meeting of the Incor. Assn. of Munic. & Co. Engrs. Discusses the details of a well-designed track. Ill. 4500 w. Elec-Engr, Lond—July 19, 1901. Serial. 1st part. No. 42416 A.

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Electric Transfer Table (Chariot Electrique à Niveau). M. Sabouret. A description of the transfer table used in the new station of the Orleans railway at Paris for handling the electric locomotives. The construction avoids the use of a depressed track. 2000 w. 1 plate. Rev Gen des Chem de Fer. May, 1901. No. 42223 H.

Transfer Table Without Pit (Chariot Roulant Sans Fosse). M. Cartault. A description of the electric transfer table used by the Paris, Lyons, Mediterranean Railway; constructed without requiring a pit or depression for the tracks for the table. 2000 w. 1 plate. Rev Gen des Chem de Fer—June, 1901. No. 42225 H.

Tunnels.

See Civil Engineering, Construction.

Tunnel Ventilation.

The Ventilation of Railway Tunnels Under City Streets. Editorial discussion of the complaints in regard to the tunnels leading to New York. 2300 w. Eng News—July 11, 1901. No. 42117.

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The New Railway from Paris to Versailles (Novelle Ligne de Paris à Versailles). A. Dumas. With map and profile of the road, and many views of stations and bridges on the section from Issy-les-Moulineaux to Meudon-Val-Fleury. 4000 w. 1 plate. Génie Civil July 6, 1901. No. 42208 D.

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The Metropolitan Railway of Vienna (Le Chemin de Fer Métropolitain de Vienne). René Philippe. A very full account of the municipal railway, elevated surface and tunnel, and its suburban connections, in Vienna. Serial. Part I. 9000 w. 4 plates. Rev Gen des Chem de Fer—June, 1901. No. 42227 H.

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The Designing, Construction, and Maintenance of Sewerage Systems. By A. Prescott Folwell. Fourth edition. Size 6 in. by 9 in.; pp. 445. Price, $3.00. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

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Torpedoes and Torpedo-Vessels. By Lieut. G. E. Armstrong, late R. N. Size, 5 in. by 7½ in.; pp. 306. Price, 5 shillings, $1.50. London: Geo. Bell & Sons.

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Water Supply.

Water Storage, Cache Creek. California, By Albert E. Chandler. Size 6 by 9 in.; pp. 48. U. S. Geological Survey, Washington, D. C., U. S. A.

Pamphlet No. 45 in the series of Water-Supply and Irrigation papers, giving the results of a study of the storage possibilities for water-supply and irrigation uses of Cache Creek Basin, California, having a drainage area of about 1,200 square miles. Much information is given as to topography, rainfall, existing irrigation works, dam sites, etc., but with a marked lack of logical order in presentation or definiteness in conclusion.

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